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[OFFICIAL NOTICE.]

Respecting the Official Work of the American Gas Light Association.

AMERICAN GAS LIGHT ASSOCIATION,
SECRETARY'S OFFICE,
530 Broadway, N. Y., Dec. 13, 1904.

To the Members American Gas Light Association: As there seems to be some misunderstanding respecting the standing of the official management of the Association, members will please note that the undersigned is the Secretary of the Association, and that Mr. A. E. Forstall is carrying forward the work of the Practical Class. All correspondence in connection with the Practical Class should therefore be addressed to Mr. A. E. Forstall, 58 William street, and all other matter pertaining to the Association to MR. GEORGE G. RAMSDELL, Secretary, at the above address.

[OFFICIAL NOTICE.]

Twenty-eighth Annual Meeting, Western Gas Association.

WESTERN GAS ASSOCIATION,
OFFICE OF SECRETARY, NEW ALBANY, IND.,
April 27th, 1905.

To the Members of the Western Gas Association: The twenty-eighth annual meeting of the Western Gas Association will be held at the Auditorium Hotel, Chicago, May 17, 18 and 19, and will be called to order by the President, Mr. O. O. Thwing, of St. Louis, Mo., at 10 A.M., May 17th.

The Auditorium Hotel has also been selected as headquarters, the rates in which are as follows: European plan: Rooms, single, without bath, $2 to $3; single, with bath, $3.50 to $4; double, without bath, $3 to $4; double, with bath, $5 to $6.

The following papers will be presented:

"The Practical Enrichment of Low Candle Power Coal Gas with Benzol: Its Convenience and Advantages," by Mr. Fred. B. Wheeler, Detroit, Mich.

"Cement Joints," by Mr. Jacob D. von Maur, St. Louis, Mo.

"The Ideal Corporation," by Mr. N. D. Cochran, Toledo, O.

"The Prevention of Stoppages in Services, Meters and House Pipes in Cold Weather," by Mr. Irvin Butterworth, Grand Rapids, Mich.

"Coal Sampling and Test," by Mr. W. B. Calkins, Fairmount, Va.

"Acetylene," by Mr. J. M. Morehead, Chicago, Ills.

"The Rotary Blower and Exhauster: Its Construction, Efficiency and Application," by Mr. George C. Hicks, Connersville, Ind.

"Kansas Oil," by Mr. K. M. Mitchell, St. Joseph, Mo.

"Texas Oil," by Mr. Thos. D. Miller, New Orleans, La.

"Report and History of the Western Gas Association's Exhibit at the World's Fair," by Mr. F. H. Shelton, Philadelphia, Pa.

"Experience as an Exhibiter at the World's Fair," by Mr. O. N. Guldlin, Fort Wayne, Ind.

"The Evolution of the Engineer," by Mr. B. E. Chollar, Kansas City, Mo.

"Wrinkle Department," edited by Mr. W. A. Baehr, St. Louis, Mo.

A short topic on the "Use of Tar as Fuel in Bench Firing," by Mr. F. C. Sherman, New Haven, Conn.

Reduced rates on the certificate plan have been obtained from the following Passenger Associations: Central Passenger Association, Western Passenger Association, Trunk Line Association, Southeastern Passenger Association, New England Passenger Association, excepting the Eastern Steamship Company.

The territory embraced by the above associations is located in all the States east of the longitude of Denver and Cheyenne, excepting Texas, Oklahoma, Indian Territory, Arkansas and the southern half of Missouri. Persons attending will obtain from railroad agent at starting a certificate stating that full fare has been paid to Chicago for the purpose of attending the meeting of the Western Gas Association. These certificates are to be given to the Association's Secretary, who will make proper indorsement, turning them over to a representative of the Passenger Association who will be present, and from whom members will obtain them upon the payment of 25 cents. This will enable the holder to purchase a return ticket at one-third the regular rates.

Going tickets can be purchased from May 13th to May 17th, and will be good returning, from May 18th to May 22d.

Rates are obtainable by all who may attend the Association meeting regardless of membership. Persons not living in the above territory are advised to purchase tickets to nearest point within said territory, and from there purchase on certificate plan a ticket to Chicago.

The local committee states that arrangements have been completed for a dinner, with a vaudeville entertainment on the evening of Thursday, May 18th, at the Chicago Athletic Club, and is practically a repetition of the plan of entertainment provided for the Western Gas Association at its last meeting in Chicago. The charge for the above entertainment is $5.

The luncheon for the ladies is to be given about 1 o'clock, the after-

noon of Thursday, together with an entertainment at one of the Chicago theaters in the evening. Should more than one lady accompany a member a charge of $2 will be made for each additional.

An invitation is cordially extended to members of other Associations to be present and take part in the discussions.

Membership blanks will be mailed to members, and they are urged to use their endeavors in securing new members from among their immediate associates. JAS. W. DUNBAR, Secretary.

BRIEFLY TOLD.

THE STATUS OF THE GAS INVESTIGATION.—The legislative committee, to which was intrusted the task of "investigating" the conditions governing the supply of gas and electric currents in the city of New York by the companies concerned therein, under mandate and seal of the State, is supposed to have ended its labors. What the supreme recommendations of capitalist Stevens, ordinaries, like Apgar, Merritt, Grady and "the other one," may be is not at this time of writing known; but we are assured that the recommendations were to be forwarded to Albany this morning (Friday) by way of the Empire State Express. The testimony advanced, from a strictly technical point of view, included the revelation that candle power can be accurately determined by means of a Jones jet photometer, and if the committee will surely recommend, "among other things," that Chief Bradley and his associates may use that instrument as the arbiter of candle power, between the demands of the State, city and consumer, and the agreements of the Company thereto and thereunder, the Company might consent to a sensible reduction in the general selling rate. Meanwhile the personal labors of the committee are finished in New York, only to begin in Albany, and to end there. For it was said yesterday by Assemblyman Merritt, referring to the question as to whether or not the "proposed bills" would have to be submitted to Mayor McClellan, that (according to the New York *Sun*): "The Republicans are responsible for this legislation. They should not share the responsibility with the Mayor. It will be easy to make it a general measure, by making it apply to cities of more than 1,500,000 inhabitants. Of course, this would mean New York alone, but then it would be complying with the letter of the constitution;" and there you are. Meanwhile, it may be said the Company will not submit to a reduction in the current rates, without exhausting every recourse that it has to the laws of the land, which in the end may be safely counted on to determine where regulation ends and confiscation begins.

NOTES——

MR. PIERRE PLANTINGA, President of the Gas Machinery Company, of Cleveland, O., sailed last Wednesday for a 3-months' stay in Europe. After a few weeks' rest from his recent very active business life, which rest will be mainly spent at his home in Holland, he will visit among the gas fraternity abroad in connection with the interests of his Company.

MR. E F. GALLAGHER, the active man in the affairs of the Ionia (Mich.) Gas Light and Coke Company, has been elected Mayor of Ionia.

LAST month Judge Lewis rendered a decision that has more than a passing interest to lighting companies. It was in the case of the State of Minnesota ex. rel. H. M. Comfort vs. the St. Paul Gas Light Company and the Edison Electric Company, and the officers of the two Companies, finding for the respondents in every point of contention, and assessing the costs of the action upon the relator, Comfort. The action was one tried during the February term of court, and it attracted a good deal of attention at that time. Mr. Comfort began proceedings to force the Gas Company to furnish him with electric current to be resold by him to parties living in the immediate neighborhood of his home. He had formerly entered into a contract with the Company, and had set up a motor and other generating machinery in his home to enlarge and transmit the current so that it might be used for lighting purposes in the homes of neighbors. The Company became suspicious of the amount of electricity really used and the amount which the meter in Comfort's home showed him to be using. A check meter was accordingly placed on the line and results tallied by the two meters. Although both were correct in their measurements, they were so widely different that the Company at once refused to longer supply Comfort with electric current. In his decision Judge Lewis found that the relator was not entitled to a contract with the respondent Companies, as he had willfully and continually violated the terms of the contract first entered into.

[Report of Proceedings.—Continued from page 650.]

TWENTY-FIRST ANNUAL MEETING, OHIO GAS LIGHT ASSOCIATION.

HELD AT PITTSBURGH, PA., MARCH 15, 16 AND 17, 1905.

SECOND DAY, MORNING SESSION.

The Association reconvened, pursuant to adjournment. The President announced that Secretary Jones was suffering from an attack of pleurisy, and that Mr. C. A. Schwarm would act in his place.

The President then introduced Mr. E. D. Johnson, of Connersville, Ind., who read the following paper on the

INSTALLATION AND CARE OF EXHAUSTERS.

The installation and care of gas exhausters are matters, judging from our experience, that do not receive the best of attention in all gas works. By first properly installing the exhauster, and then a few minutes each day given to the care of the machine, a large amount of expense and trouble can be obviated.

Foundation.—In installing the machine a solid masonry or concrete foundation is always preferable, even for the smaller sizes. The depth of the foundation will depend upon the weight of the machine and the character of the ground where the installation is to be made. If, for any reason, it is necessary to place the exhauster and engine higher than the ordinary surface of the ground, then, in such a case, if it is at all possible, build the foundation to the required height; but if this is impracticable, then the superstructure should be of steel, well braced to the walls of the exhauster room. I have seen medium sized exhausters and engines installed on an ordinary floor, with a cellar under it, and without any extra bracing under the floor to prevent vibration. In other cases the exhausters have been placed on heavy timbers which were set in the ground, and it was only a matter of a comparatively short time until new foundations would have to be provided. The best is always the cheapest when it comes to the matter of foundations.

First Essential.—The first essential in installing an exhauster is to get the machine perfectly level both ways. The operating parts are fitted so closely in the case of the exhauster that if it is placed in the slightest twist in being installed the parts will bind.

Connecting In and Outlet Pipes.—One of the most common causes of trouble in setting an exhauster is in connecting the in and outlet pipes. Very frequently, when the flanges of the pipe connection do not come square with the flanges of the pipe plates of the exhausters, the man in charge of the work will draw the flanges together with the bolts, thus springing the case of the exhauster to such an extent as to cause knocking or a binding of the operating parts. Care should always be taken in making these connections to have the flanges of both machine and pipes perfectly square with each other, and also see to it that the weight of the pipe connections does not come upon the exhauster.

As a usual thing, when an exhauster with side in and outlets is being connected, the pipes run down under the floor or ground vertically and elbow into the system of piping about the works. In order to prevent the weight of the pipe connections coming on the exhauster, the best plan would be to have an iron foot cast on the elbow connecting the vertical pipe from and to the exhauster and the horizontal pipes in the ground. This foot, resting on a pier of masonry or concrete, will take the weight of the vertical section of pipe, and by the use of shims under this foot the flange of the elbow at exhauster can be brought to the exact height, and this elbow can be turned so that a perfectly square joint can be made. If it is found that the piers upon which these feet rest settle, then shims can be resorted to again to remove the strain caused by the weight of the connections.

Internal Heating.—Another cause of trouble (which is not always so apparent) is the thrust of the crankshaft of the engine, which causes heating on one or the other end of the exhauster. Sometimes the end heating is caused by the machine not being set perfectly level; but the trouble can usually be detected and the cause located by taking out the bolts of the coupling. If there is any misalignment, the coupling flanges will indicate the trouble by their position with relation to each other. If there is a twist in the bed plate, the flanges will show the direction of the trouble, and the bed-plate can be adjusted until the coupling flanges come square and flush with each other. The machine is then in line, and there will be no binding of the operating parts by reason of misalignment. If, however, when the coupling bolts are taken out and the flanges remain practically flush all around and bind each other or spring away, then this is caused by the thrust of the engine shaft, which thrust is caused by wear in the engine bearings, or the natural operation of the engine, which usually thrusts its shaft

ome way or the other while in motion. If the exhauster impellers bind on the end farthest from the engine then the coupling flanges will bind when the bolts are out. The remedy is to bump the engine with a short piece of timber, away from the exhauster, until the amount of the thrust is overcome, re-ream the dowel holes, drive in the dowels and the heating disappears.

If the impellers bind on the end nearest the engine, the coupling flanges spring apart when the bolts are removed. The remedy is to bump the engine toward the exhauster until the coupling flanges meet, secure the engine to the base, as described above and the heating will disappear. Nine times out of ten one of the above suggestions will apply to troubles experienced in installing an exhauster.

Daily Care.—Once an exhauster with engine is thoroughly well installed and adjusted for its regular work, the care of the machine should be an easy task. There are three cardinal points to observe in caring for an exhauster: 1st, keep all the accessible parts of the exhauster, engine and governor clean and free from superfluous oil, tar and dirt; 2d, by daily observation see that all adjustments are kept up, both as to the setting of the machine, as well as the adjustable parts of the exhauster and engine; and, 3d, see that all parts requiring lubrication are never neglected. Oiling should also be a matter of daily care and attention. Where the self-oiling feature is used in the journal box, it is only necessary to remove the oil from the reservoir every 3 or 4 months and return it for additional service, with now and then a little fresh oil from an ordinary oiling can.

It is astonishing what negligence there is along this line. We have frequently sent out experts in answer to telegrams requesting us to send a man to examine an exhauster, and to use the expression one of our men used, "I had to take a pick and shovel to get to the machine." The exhauster is often placed in a dark corner or room, and it is no exaggeration to say that very often after the machine is set it receives little or no attention. We have frequently had exhausters returned to us for an overhauling that were literally covered with tar and grease, and, judging from the condition of the machine, had never had a bearing adjusted, and apparently the operator had stood off and squirted oil at the bearings.

Gear Lubrication.—Another important point in the care of an exhauster is to keep the gears well lubricated with a very heavy oil; or, what is better, a mixture of plumbago and good quality of grease. This reduces the wear of the gears to the minimum. The office of the gears is to maintain the impellers in their proper relative positions, and this feature, together with the proper adjustment of the journals, maintains the efficiency of the exhauster, as well as adding to its durability.

Stuffing Boxes.—Special attention should be given to the care of the stuffing boxes. I am of the opinion that more trouble is experienced after the installation of an exhauster on account of inattention to the stuffing boxes than any other cause. If the packing is neglected, it is only a question of a short time until the tar and ammonia work out and get into the bearing. This is, of course, destructive both to the journal and bearing. Mention has already been made of the gross negligence of exhausters in allowing the packing to work loose to such an extent that tar and grease become caked all over the end of the machine. It is apparent at once that such neglect is ruinous to a machine that is of the utmost importance to the successful operation of a gas works. I have seen machines that have come back to our works for an overhauling where the tar has not only worked into the journal box and almost destroyed it, but has also worked over into the gear housing. This can all be avoided by simply renewing the packing as often as practice teaches it should be to keep the machine absolutely clean. Square flax packing is probably as good as any that can be secured.

Removing Coal Tar.—It happens sometimes that an exhauster remains idle for a short period and difficulty is experienced in starting the machine on account of the tar having become hard while the exhauster has been idle. This is overcome by introducing benzine or coal oil through the sight-feed oilers placed on top of the case. By this means the tar is softened and cut, and the exhauster can again be operated.

Place for Exhauster.—The exhauster should always be placed in a room where there is plenty of light, so that all the adjustments can be properly watched. Care should be taken in having the exhauster so there should be ample space about the machine to admit of getting at all the parts without trouble; for if the location of the exhauster is such as to make the care of it troublesome some of the above points will likely be neglected.

If in the above paper I have made any suggestions that will enable anyone to avoid expense and trouble with their exhausters, I will feel repaid for having written it.

Discussion.

The President—You have heard an excellent paper, and I wish we could have a free and full discussion of it. If there is any point that Mr. Johnson has left any doubt about I know he will be glad to explain, or if there is any point to which any member desires to refer by way of discussion, such is now in order.

Mr. Schwarm—I would like to ask Mr. Johnson what packing he would advocate for ordina y practice?

Mr. Johnson—We find that square flax packing is very satisfactory.

Mr. McDonald, Louisville—Mr. Johnson says that the journals should be adjusted and the packing renewed as often as should be shown to be necessary. I would like to know about how often that would be? Mr. Johnson has care of 300 or 400 exhausters, and most of us have care of only one, so I am sure we would all appreciate the value of his experience as compared with many of us. I would like to inquire about how often the packing has to be renewed and about how often the journals require readjustment.

Mr. Johnson—I presume the time packing ought to be renewed would be when there would be any appearance of tar or any escape through the boxes, or if the packing becomes hard. It can be examined without being taken out, and if it becomes hard it should be taken out, whether there is any tar in it or not. It is a matter of examination to see whether or not the packing is kept lubricated while in the box. If not, then it will harden easier and more often and will have to be renewed more frequently. It is simply a question very largely of the judgment of the man who cares for the machine.

Mr. Osbourne—I think it depends a great deal on the kind of exhauster. I remember, in my experience, an exhauster which ran, I believe, for 9 years without having to be repacked—you might think that was stretching it but it is a fact—and when I left the place it was still running and there was no appearance of tar or anything of that kind; but it was pumping coal gas and the gas was always about the same temperature. There was not much expansion or contraction on the parts by reason of the change in temperature of the gas pumped and it went right along without giving any trouble. I believe it has been there for 12 years. It just "keeps going," as the fellow says. It works 24 hours a day without the least trouble. I happened also to have had experience with another which I think had to be re-packed about every 3 weeks, owing to the fact that through neglect the bearings had gotten all thickened up. After it was lined up and fixed in good shape it worked a great deal better.

Mr. Steinwedell—I noticed a reference in Mr. Johnson's paper to the adjustment and management of the exhauster governor and the governor valve. In small works the exhauster is run by the retort house hands. They are not mechanics to any great extent, and find they often ask questions about how the exhauster governor should be regulated. A knowledge of the proper adjustment and management of the exhauster and governor valve is also necessary and is easily acquired, if the design and working of the machine are well understood. Care must be taken to put the parts together so that the joints work freely, and to see that no red lead or other material used in making pipe joints be allowed to get into the steam valve and cause it to stick or work hard. The packing around the valve stem should not be screwed up tight enough to cause unnecessary friction. The pipe connecting the governor with the inlet side of the exhauster causes the governor to act according to changes in the amount of gas made. When the machine is set up, open the air cock on the governor float, push the float down until its top is even with the top of the outside tank, then fill about half full of water, pouring slowly, so that the water will have time to displace the air and rise to the same level in each chamber of the tank, then close the air cock. Set the steam valves so that all of the steam will go through the governor valve. Turn on the steam gradually and see what adjustments are needed. If the boiler pressure is high and the engine runs too fast for the amount of gas made, lengthen the connecting rod, by means of the turnbuckle, thus closing the steam valve. If the engine runs too slow, shorten the rod. If the vacuum is too great, remove some of the counterbalance weight. If not enough, put on more weight. If the governor is too sensitive to small changes of pressure and causes the speed of the engine to change suddenly, lower the end of the connecting rod in the slot on the governor tank. If not sensitive enough, raise the rod in the slot. If the float swings up and down, opening the steam valve wide and then closing it completely, close the valve in the gas pipe to the governor float so that it will throttle the flow of gas through it and thus tend to hold the float steady. If it is ever necessary to take the governor or valve out, the steam by-pass valves can be turned so as to by-pass the steam, and then the valve can be removed without stopping the ex-

hauster. The above suggestions should prove ample for the proper adjustment of the governor so that it will regulate within the capacity of the exhauster. Furthermore, I think in tightening up the anchor bolts care should be observed that the bed of the exhauster is not sprung. That is, the exhauster bed should be well and evenly shimmed up and grouted in cement or some other suitable substance. Before connecting the inlet and outlet pipes the exhauster should be thoroughly cleaned of all grit, cinders and other dirt that may have accumulated during shipment or installation.

Mr. G. Whysall—Referring to the difficulty in starting the exhauster after it has been out of service for some time, if on sending the exhauster down benzine is used in the lubricating cups, you will wash the exhauster walls, and when you get ready to start it up it will not stick. This is an easy way to obviate the difficulty referred to.

Mr. C. G. Atwater—I want to add a few remarks about "sticking" exhausters. We had some trouble with a plant for long distance gas transmission in which two exhausters coupled to a single shaft were driven by an engine belted to a pulley between them. These exhausters regularly stuck, if they were shut down for an hour or longer, and had to be pried loose before they would start. The makers examined them but did not overcome the trouble. We tried steaming them before starting to soften any tar that might have hardened on the paddles, and also used kerosene oil to cut out the tar. We also slackened the side plate bolts to give the paddles more end play and even put a thin gasket in them. Some one of these methods or all of them always succeeded after a while, but no one method seemed invariable. There was no tar to be found in the gas by ordinary tests, and the only condensation in the pressure line was oil or water. I might ask if there is any difference in comparative methods between the float governor and the diaphragm governor?

Mr. Johnson—I think Mr. Hicks may be able to give you more information on that subject than I can.

Mr. G. C. Hicks, Jr.—In answering that question it is rather hard to come to any definite conclusion on account of the fact that the application of the two styles is not necessarily the same, and in most cases is not the same. The diaphragm governor is used generally for higher pressures and for governing engines where they are running more nearly at their rated load. The float governor is to control conditions where the pressure must be kept very even and where the engine is usually underloaded so it has to be very sensitive in its adjustment. In our experience the float governor answers better than the diaphragm governor, but for service where the engine runs nearly full, or at its rated load. we find that the diaphragm governor, on account of its simplicity and ease of application, can be put directly on the engine if necessary and not on the exhauster at all, and is the more feasible and practical governor of the two for that purpose. That is as near as I can come to answering the question.

Mr. Steenbergen—I would like to ask if anyone has had experience in the use of oil in a tank instead of water? We have had trouble with our tanks rusting out about every 6 months, and we even considered the use of copper or galvanized iron. We have ascertained, however, that the use of oil in the tank seemed to remedy this difficulty. We had one in for two years which we treated in this way without rusting out.

The President—One thought occurred to me during the reading of the paper that has not been touched upon particularly. I have seen exhausters that pounded or "knocked" inside without apparently any reason for it and not periodically, so that you would imagine it was when one of the wings came around, but it was occasionally. What would you do in a case of that kind? What is the cause of it and what would be the remedy?

Mr. Johnson—Do you mean after the exhauster has been installed for a while?

The President—Yes, after the exhauster was installed for some time at least there would be occasionally a knocking of the impellers on the inside. Not a regular knocking or periodical knocking, but occasionally without any apparent cause for it that we could discover.

Mr. Johnson—It would be pretty hard to tell what was the cause of it. If it were a comparatively new machine I do not see what would cause it unless there would be some kind of a deposit in the exhauster that would accumulate and harden and the knocking would be the remedy, thus doing away with the accumulation or deposit if such existed. I cannot imagine what would cause the exhauster to knock occasionally without any apparent reason.

Mr. Hicks—That happens sometimes in a case where the adjustments are worn down a little and the impellers are very close to the bottom of the case. A slight increase in pressure may just bring it to the critical point so as to give the whole machine a little here and a little there, bringing the impellers down to the touching point of the case. When that pressure goes off again the knocking would cease. Another cause for it, as Mr. Johnson said, is the accumulation of dirt. If there is any accumulation of either dirt or tar as the parts of the machine work together, this accumulation will thrust the two away from each other, forcing them to hit the case. Those are the two most frequent causes for irregular knocking. One other cause that I am reminded of is temperature. An excess of temperature might cause a little binding and produce a knocking, and any machine that is regulated to run under one constant condition is much easier to keep in shape than a machine that has to run under variable conditions, because you may get it set perfectly for one condition and have a slight trouble with it if you are operating it under another condition. In that case, with the machine running under more variable conditions as to temperature, etc., a machine should be built a little more open, which I think would prove a solution of that difficulty.

Mr. Atwater—Regarding the effect of temperature on an exhauster, I have seen an exhauster shoved out of its position and made to knock seriously by the expansion of the connections due to the difference between summer and winter temperature. The cast iron line to the exhausters ran from outside the building directly to the exhauster inlet, and was about 24 inches diameter. The exhauster was of the vertical type. The action of the temperature variation was the only cause that seemed to reasonably account for the trouble. The pipe was connected to the apparatus outside the building and was exposed to the winter cold and summer heat. The exhauster had shifted a tenth of an inch on its bed and lifted somewhat, moving slightly at each stroke and a knock appeared in the coupling between it and the engine. When uncoupled the exhauster moved freely and was apparently all right, and there was no tar clogging. An expansion joint was designed to take up the thrust of the expansion, but temporary re-adjustments and remedies aided enough to make it possible to wait till colder weather removed the difficulty. I mention the point to show that the connections to the exhauster can have considerable to do with trouble in its internal workings.

Mr. Whysall—I would like to suggest the use of the steam turbine for guiding the exhausters instead of reciprocating engines as now used. I believe we would get better regulation, and they certainly require less attention and would be less expensive to operate. The efficiency, I believe, would be as high if not higher than with the reciprocating engine as we find it in use to-day.

Mr. Klumpp—Mr. Whysall spoke of operating exhausters by means of turbines. The present positive exhauster runs entirely too slow to allow of a satisfactory reduction of the turbine speed to be suitably adopted, especially in connection with the smaller turbines where the speeds are enormous. The adoption of the turbine for direct driven centrifugal exhausters or for blowers is a different proposition, and such installations are in general satisfactory use. It is preferable to operate the turbine at a constant maximum speed for best economies.

Mr. Schwarm—In one of the plants conducted by our company in a town of about 5,000 people we drive the exhauster with a water motor which costs us about $100 a year. It is the most satisfactory power I ever saw for driving an exhauster. It works perfectly. We have no trouble with it whatever and the expense is very light.

Mr. Hicks—Is that city water pressure?

Mr. Schwarm—Yes, sir.

Mr. Osbourne—I would like to know what the cost of that water is?

Mr. Schwarm—It costs us between $90 and $100 a year to run the machine.

Mr. Osbourne—I don't mean that; I mean the cost of the city water.

Mr. Schwarm—I could not say as to the cost per 1,000.

Mr. Whysall—What is the size of the exhauster?

Mr. Schwarm—Six-inch, handling in the neighborhood of 1,000 to 2,000 per hour. It is a small plant.

Mr. J. R. Lynn—I think the adaptability of a water motor would depend upon the generosity of the water company.

Mr. Johnson—Concerning the matter of packing which has been mentioned. One gentleman spoke about having the packing remain in the exhauster for 9 years. That might speak well for the packing or the exhauster or something else. If, however, any of you have charge of an exhauster I would advise you never to allow that to occur. The packing is bound to get hard, and it should be renewed, whether the tar gets into the box or not, I should say every 3 months at least.

Mr. Osbourne—The reason I made that statement was because the writer of the paper spoke about it as though it was a matter that should be taken care of when it was needed. I will say that that exhauster

has been running 12 years, 24 hours a day; never stopped. But the conditions are very favorable. The gases are always of the same temperature, or practically the same, so that you have no difference in temperature in the gas which would cause any expansion or contraction, and it is one of the self-lubricating kind which takes care of the oil properly. To my personal knowledge I know that the packing has not been changed for 6 years. I will not go any further than that, but I think I am safe in saying that it has not been changed for 9 years.

Mr. Johnson—The exhauster may not have needed it, but the packing needs it every 3 months at least.

Mr. McDonald (Ky.)—Mr. Johnson is at last "'fessing up" about packing. Now, I would like him to say something about journal boxes. Are they to be left there until they give trouble or are they to be adjusted before they give trouble? My experience with a machine is that as long as it runs all right you better leave it alone, for if you let the ordinary machinist get at it, it will not run quite so well after he is done with it. (Laughter.)

Mr. Johnson—As far as that is concerned, Mr. McDonald, it is a hard question to answer unless the conditions are stated.

Mr. McDonald—In other words, how many years of continuous running at an ordinary speed will the exhauster stand if it is well treated before the journal boxes need readjustment?

Mr. Johnson—That is rather a hard question to answer without knowing more of the existing conditions, but I should say at least 5 years, if it is well cared for, without any adjustment.

Mr. G. N. Clapp—I think that the number of years any machine will run would depend considerably upon the revolutions. Certainly a machine that was run at a very fast speed would need attention much sooner than one which was run at a slow speed. Now, the gentleman sitting in front of me says that he knows of one that ran for 9 years. That machine may not have done any more work in those 9 years than some other machine in 1, 2 or 5 years. My experience with machines has been that it is better and cheaper to keep them as nearly new as possible, and that can be determined to some extent by the amount of work done by the machine. Some of the speakers have called attention to the fact that the men around machines did not know how to take care of them. I think it is not so much ignorance as it is carelessness. I think if the superintendent, or whoever has charge, will call attention to it frequently they will get the proper attention. But to have a specified time for repacking or readjustment or repairing, I think that would not apply to any large number of concerns. It might apply to one or two, but I think it depends almost entirely upon the amount of work done by a particular machine.

Mr. Osbourne—I simply called attention to the experience I had had with reference to the packing in this exhauster lasting for the length of time stated, because taking out your packing every 3 months would be an awful job. That is the only fault I have to find with Mr. Johnson's exhauster. It is an awful job to take that packing out and renew it. In the works I spoke of where the exhauster ran for such a length of time it had good engineering care and was looked after by a man who knew how to take care of it. The engineer himself gave it his personal care and that makes a great deal of difference.

Mr. Hicks—A remark I would like to make about packing is that ammonia is a most destructive element in any packing. All packings depend for their flexibility more or less upon the animal and vegetable oils in them. Ammonia cuts them right out and dries them up. The only way to get a long life in packing is to keep it soft and pliable by either laying it in graphite at the start, or oil, or keeping them oiled up occasionally, say every two weeks, by putting a little oil into the packing so as to keep it soft, and in that way you can double or treble the life of ordinary flax packing.

Mr. Lynn—Reference was made to a galvanized or copper float. I do not think any manufacturer of an exhauster would advise anybody to use a galvanized or copper float unprotected. The galvanized float would be very undesirable unless it had some good protection and a copper float would be considerably less desirable.

On motion, Mr. Johnson was tendered a vote of thanks for his practical and valuable paper.

The President—The next paper will be by Mr. W. H. Hammon, of Pittsburgh, Pa., on the subject of

LONG DISTANCE TRANSMISSION OF GAS.

Unfortunately, Mr. Hammon has been so very busy that it was utterly impossible for him to prepare this paper in time for printing. In fact, it was not completed until within the last day or two. There are some mathematical problems worked out in the paper and I would like the members while Mr. Hammon is reading the paper to be as attentive as possible, for only in this way will they be able to get the full benefit of it.

Mr. Hammon prefaced the paper in these words: Mr. President and Gentlemen—I feel a little bit like a boy reading a Greek oration. The little mathematics in the paper are very simple but without something to follow it it would indeed be Greek to attempt to make it plain, so that parts of it you will have to take for granted. If it should afterwards be published you will then have an opportunity to examine it more closely.

Mr. Hammon then read the text of his paper, as follows:

The problem of long distance transmission of gas has in recent years been receiving continually increased attention. The conditions which have brought about this result are many. Among the most prominent are the important experiments and interesting and able papers by Mr. F. H. Shelton on the economies resulting from the use of a larger central plant and the distribution therefrom of artificial gas at a relatively high pressure to several neighboring cities or villages. The distribution of commercial power in the form of compressed air from a central station to mines, quarries and other relatively distant points has been another application of the same principle. But probably in a greater degree than any other has attention been directed to this problem in the transportation of natural gas. This discussion refers especially to the latter application, although in many particulars the principles are equally applicable to other industries. Until approximately 10 years ago cities using natural gas secured their supply from nearby fields and the work of conducing it 50 or 100 miles was practically unknown and by some intelligent men was considered almost impossible. In fact it has been stated that not many years ago one prominent man engaged in the natural gas industry expressed it as his opinion that if gas, being elastic, could be propelled through pipes, it must be done by placing exhausters at the discharge or low pressure end of the line and lowering the pressure on the line, thus "pilling" the gas, because if there were an attempt to force from the high pressure end the gas would compress, and "like rubber," the friction against the sides of the pipe would increase so rapidly as to tend to dam and obstruct rather than to increase the flow.

The partial depletion of the fields near the market, rendered necessary, either: (1) An increase in the output from wells by pumping; (2) the delivery of gas from more distant fields, or (3) the abandonment of extensive and valuable distributing plants.

Both the former methods have been tried to prevent the latter contingency. Many good low pressure pumps have been put in operation. They have reduced the pressure on the lines at the mouth of the wells and thus increased their output, and at the same time furnished the power to propel the increased output to the market. Lines were also run to more distant fields.

By a repetition of these methods in even more distant fields the process of transporting gas has been extended until now it is being successfully and economically propelled from points near Weston, W. Va., to Toledo, O., a distance of 300 miles. Four companies are supplying the vicinity from points in Lewis, Harrison and Doddridge counties, W. Va., a distance of more than 100 miles through 5 or more lines 16 inches in diameter and upwards. The amounts transported sometimes equal as much as 400,000,000 cubic feet in a single day. Cleveland and cities in Northern Ohio are being supplied at times of maximum demands with nearly 200,000,000 feet more from sources from 100 to 200 miles distant, and at present work is being hastened to completion by which 200,000,000 cubic feet daily will be propelled more than 150 miles from the fields in Kansas and Indian Territory.

In the carrying out of these undertakings, many problems of interest to the engineer have arisen, several of which are here referred to. They are generally classified under two heads: 1st, pipe line problems; 2d, propelling problems.

Pipe Line Problems.—In considering the most economical laying of pipe for a gas line, in order that it may furnish the required quantity of gas, the following should be considered: (a) cost of pipe; (b) cost of laying; (c) rate of depreciation and repairs

It can be shown that after a certain uniform thickness of pipe is allowed for corrosion (about $\frac{1}{16}$ of an inch) then the safe working pressure of a pipe varies inversely as the diameter; and the cost within certain limits varies as the square of the diameter, and the ratio of the cost to the output of line, with constant intake and discharge pressures, is proportional to the reciprocal of the square root of the diameter of the pipe. These problems are somewhat interesting to solve, but as the pipe mills decline to make pipe capable of standing less working pres-

sure than 300 pounds to the square inch, in sizes of less than 10 inches, and as the additional expense of laying and operating larger lines becomes excessive at a much higher pressure than 300 pounds, the problems have chiefly a negative value. They are, however, as follows:

Cost of Pipe.—The cost of the pipe within the limits of sizes ordinarily employed for main, *i. e.*, in sizes from 4 to 16 inches in diameter, is approximately proportional to its weight. The force exerted by the pressure of gas tending to burst the pipe longitudinally at any given point, is for unit length:

Force = d p where
d = diameter of pipe and
p = pressure of gas.

This force will be resisted by the tenacity, of the metal at the points *A* and *B*, being equally divided between the two, therefore, the resistance to the pressure = 2 ct_t where—

ct = co-efficient of tension of the metal
t = thickness of plate.

Since the pressure and the resistance are equal, the formula becomes:

(A) $$d\,p = 2\,c_t t.$$

From this it is noted that the thickness of the pipe is proportional to the pressure it must hold. As the weight, and consequently the cost, of the pipe are proportional to the thickness and circumference, we have cost as follows:

Cost: Constant c X wt = CX cir. Xt, which is C $\overline{11}$ dt substituting the value of t from the equation (A), we have cost—

$$\text{Cost} = \frac{c\ \overline{11}\ D^2P}{2\ ct} \text{ placing C for } \frac{c\ \overline{11}}{2\ ct} \text{ we have}$$

(B) $$\text{cost} = C\ d^2p,$$

or the cost for the pipe in a line of varying pressures, is as the square of the diameter of the pipe, and directly as the pressure it will hold.

The formula for the flow of gas through a pipe line at high pressure, with constants, determined by Mr. Forest M. Towl, is:

(C) $$q = 48\sqrt{\frac{(p_1^2 - p_2^2)\,d^5}{L}} \qquad 48\sqrt{\frac{(p_1^2 - p_2^2)\,d^5}{L}}$$

in which q = the cubic feet of gas discharged in 1 hour.
p = absolute initial pressure in pounds—*i. e.*, gauge pressure + 14.7 pounds.
p_2 = absolute discharge pressure in pounds.
d = diameter of pipe in inches.
L = length of line in miles.

From the equation we observe that the capacity of the line is proportional to the 5/2 power of the diameter, and since the cost was shown by equation (B) to be proportional to the square of the diameter, we have—

Cost : to quantity : : d^2 : d_2^5, or

$$\text{Cost} = \sqrt{\frac{q}{d,}}$$

or the cost of the pipe for lines of varying output is as the reciprocal of the diameter.

Referring again to the equation (C) for the flow of gas through a pipe line, we observe that the quantity is proportional to the square root of the difference between the squares of the initial and the discharge pressures; or,

$$q = C\ \sqrt{p_1^2 - p_2^2}$$

when we consider the diameter of the pipe and the length of the line constants.

Since from the equation (B) we find the cost is proportional to the pressure the pipe will stand, we have the ratio of the cost to the quantity of the gas cost:

$$(q \text{ as } p_1 : \sqrt{p_1^2 - p_2^2} \text{ or}$$

(E) $$\text{cost} = \sqrt{\frac{q\ p}{p_1^2 - p_2^2}}$$

And from this it is observed that when $\sqrt{\frac{p_1}{p_1^2 - p_2^2}}$ is greater than $\sqrt{\frac{1}{d}}$ it will be more economic to increase the size of the pipe in order that the quantity of the gas passed may be increased than to increase the pressure, and when $\sqrt{\frac{p_1}{p_1^2 - p_2^2}}$ is less than $\sqrt{\frac{1}{d}}$, then it will be more economic to increase the initial pressure in order to obtain an increased quantity of gas than to increase the diameter of the pipe.

When p_2 = O, then the $\sqrt{\frac{p_1}{p_1^2 - p_2^2}}$ = unity (1) and is greater than $\sqrt{\frac{1}{d}}$ for all sizes above 1 inch in diameter.

These conditions exist at the discharge end of a line; where the discharge pressure approximates O; at these portions of the line it is more economic to increase the diameter of the pipe than to increase the initial pressure. However, near the initial end of the line p_1 approximates more nearly to p_2 and in this portion of the line the value of the expression $\sqrt{\frac{p}{p_1^2 - p_2^2}}$ is small, and an increase in output can be obtained with less expense by increasing the initial pressure than by increasing the size of the line.

From the above it is observed that in laying a large line it is desirable to use small pipe capable of standing high pressures at the field or initial end, gradually increasing the size of the pipe as the discharge end is approached. This is evident also from the fact that the friction due to the flow of the fluid through the pipe is proportional to the square of the velocity, and as gas expands, due to the diminishing pressure on the line, from the initial to the discharge end, the velocity must be proportionally increased, since all of the gas flows through the entire line. Therefore, the friction being as the square of the velocity, it is desirable in the portion of the line where the velocity is greatest to make the size of the pipe maximum. However, as mentioned above, pipe mills decline to make, without extra charge, pipe that will stand less than 300 pounds pressure to the square inch (allowing an ample factor for corrosion and safety) in sizes under 10-inch in diameter. Therefore, this argument can only apply to larger sizes of pipe, or at times where the pressure shall exceed 300 pounds to the square inch.

(B.) *Cost of Laying.*—The second subject for consideration in the cost of a line is the cost of laying. The factors entering into this, as usually included, are: Right of way, freight, hauling, pitching, pipe and couplings, filling trench.

The right of way and damages are necessarily irregular, but are roughly proportional to the size of the line.

Freight varies as the weight and distance (except in pipe of very large sizes) and, therefore, as the diameter, and where pressure is considered as the square of the diameter. Hauling like freight is proportional to the weight and distance, but it is subject to great variations because of the contour, roads, weather, etc.

Ditching costs directly as the width of same, and in geometric ratio to depth, each of which is related to the diameter; the width being equal to the diameter plus a constant. The depth of the ditch in small sizes equals the depth of soil required for cover by outside conditions, to which must be added the diameter of the pipe. In larger sizes, however, the ditch must be dug to an additional depth to prevent the pressure forcing the pipe from the ditch. In large lines, therefore, the cost of the ditch is $c_1 d$, for width, plus $c_2 d^2$ for depth. Almost all work in Pennsylvania and West Virginia has been done with a spade, but in Western Ohio, Indiana and Kansas ditching machines have been more or less used.

Character of Pipe: Coupling.—One important feature in line laying, to which considerable attention has been given recently, is the character of the pipe and the joints. Until since the development of the natural gas industry, cast iron bowl and spigot pipe with leaded joints was practically the only line laid. Although still extensively laid, it is not satisfactory. Its faults are too well known to need discussion. The lack of elasticity in the packing material admits of leakage on the settling of the pipe in the ditch, shortly after laying. Changes in temperature, with no provision for expansion and contraction, loosen the lead packing. When laid in electrically charged soils, its excellent conductivity causes it to readily accumulate a large electric current, which sets up electrolytic action between the lead and the iron in the joints and thus causes leakage The writer personally knows of some extensive sections of large cast iron mains, paralleled by street car tracks, where the repairs in three years cost as much as a new line, and probably the loss from leakage was much greater. The advantage of cast iron pipe lines is that the pipe is practically indestructible; cast iron being only about one-third as expensive as wrought iron or steel, the pipe can be made three times as thick without additional cost, and the corrosion in the soil is less with cast iron than with wrought iron. With the difficulty of imperfect joint solved, there is a decided advantage in the use of cast iron pipe. In the effort to solve it cement has been used, but since this makes an absolute inflexible joint the pipe frequently becomes subject to extreme strains, due to the settling of the soil and changing of the temperature, and numerous breaks have

occurred in consequence, and usually at a time when the soil is frozen, thus preventing the escape of gas to the surface, and increasing the danger of explosion. This danger can be lessened by laying the pipe to a greater depth, but this entails decidedly greater expense, and frequent excavations on city streets will cause settling of the soil. The proximity of sewers with changeable temperatures and the frequent laying of heating and steam pipes in streets render it impossible to prevent these strains. Others have used the old-fashioned lead joints, with clamps composed of rubber packing rings held in position by iron flanges. While this is practically the only means of reducing the leakage of old, leaky joints, it is an expensive and far from satisfactory method of laying a new line.

Recently several successful cast iron lines have been laid using rubber couplings in which the packing material has been rubber and similar to those used so extensively in recent years on natural gas lines. The advantages resulting are numerous. They are:

(A.) Economy in laying. As the pipe can be connected on skids over the ditch and lowered by windlass, no large bell holes are needed as are necessary for calking or cementing. The joints are so simply and readily made that 6 men only are necessary for coupling 100 joints of 16-inch pipe per day outside of those engaged in ditching and moving the pipe.

(B.) The leakage is zero.

(C.) The breakage of pipe due to strains is zero.

(D.) Corrosion is less, as no tool marks injure the coating of the pipes.

(E.) Electrolytic action is reduced to a minimum, as the rubber packing renders it possible to insulate the joints so that the resistance of the line will prevent the accumulation of a current.

(F.) Economy of material. The cost of material in cast iron bowl and lead approximates the cost of coupling. Besides this the frequent clamps necessary to repair leaks add to the expense of the old style line.

The criticism made to rubber couplings is confined exclusively to their use with artificial gas, and this is due to the injury of the rubber by the condensible hydrocarbons in the gas. It is believed that this is more theoretical than fact, but if it exists it is a very easy matter to protect the rubber. However, Mr. Isaac C. Baxter piped a large section of Windsor, Ont., more than 8 years ago, using rubber couplings, and has never had one dollar of repairs on the joints and has *no leakage*, and many other less extensive cases could be cited. While the rubber dissolves very readily in volatile oils when the oil is permitted to enter the pores of the rubber, this is not the case when the rubber is under great compression. It has frequently been noticed that as rubber dissolves it swells to many times its original size, and since this is impossible when under compression the effect is obviated. The writer once had two nipples dead-capped on one end and the other ends were connected by a rubber coupling. The reservoir thus formed was filled with the first distillate of coal. He left the same for 30 days and at the end of that time the rubber showed no injury and was not even discolored except at the extreme inner tip that extended under the centering, which was not compressed.

For field use, where the cost of hauling would add to the expense of the cast iron pipe line, and for uses where extremely high pressure are intended, wrought iron or mild steel are commonly used. In large sized pipe the cost of the pipe is somewhat more than the cost of cast iron, but when the increased freight, hauling and handling charges, and the more fragile character of the material are considered, the cost is about the same, and the lighter kinds have almost entirely replaced the cast iron for field and transporting systems.

Formerly, for sizes of 10 inches or 12 inches in diameter and under, screw-thread joints were used, but the best modern practice is to use rubber couplings in sizes from 3-inch or 4-inch to 24 inches in diameter. The reasons for this are:

(a) Diminished cost, as the pipe is not weakened by the cutting of threads nor cut by tongs; consequently lighter weight pipe can be used and corrosion lessened by coating pipe which is not injured in coupling.

(b) Much less leakage.

(c) Less expense in laying.

The cost of laying 10-inch pipe, exclusive of digging and filling ditch, is with couplings less than one-fourth what it is with screw pipe. At present from 80 per cent. to 90 per cent. of the main lines, in sizes from 8 inch te 20-inch, are being laid with rubber couplings.

As to the relative merits of wrought iron and steel, the general preference is given wrought iron, since it is easier to cut and bend, and its corrosion under certain conditions is less; however, since the use of rubber couplings these conditions have less weight, as thread cutting is dispensed with and the bends can usually be made with the joints, and by properly coating the pipe corrosion is insignificant. Therefore, since steel pipe is somewhat cheaper, a mild, soft form of steel is commonly used.

Several other forms of pipe are quite extensively used, among which should be mentioned the Matheson joint. It is a wrought iron or steel bowl and spigot pipe, usually laid with lead packing and clamped with a rubber packing on the outside when laid. In this manner a satisfactory line has been made of large pipe, but the expense is more than that of plain end pipe and rubber coupling. It lacks the flexibility and does not admit of expansion and contraction. It has to be laid in the ditch, but only has half as many joints to leak. It is probable, however, that the percentage of leakage is more than twice as great per joint under the circumstances.

Recently some large lines have been laid abroad of the locking-bar pipe, which, it is stated, have been very successful. This pipe consists of two sheets of steel bent into semi-cylindrical shape. These sheets have the longitudinal edges butted into a dovetail. These dovetails are fitted into grooves in the opposite edges of a coupling bar of iron, shaped like a capital H, when the groove is closed up by heavy excessive pressure about the dovetailed edges, thus forming the pipe.

Large sized pipes made of plates riveted together have been used, but with only partial success, as it is very difficult to make and keep the seams tight.

Filling Trench.—This expense is directly proportional to the size of the excavation, except where the size of the pipe is great in proportion to the size of ditch when some of the dirt must be carted away.

Rate of Depreciation and Repairs.—The rate of depreciation of natural gas systems is much greater than that of artificial plants, due to the depletion of gas fields or reservoirs and the consequent necessity of frequently lifting and moving lines to seek new supplies. The average life of a natural gas reservoir from discovery to such a point of depletion as to render it unprofitable to market the gas therefrom, is from 10 to 15 years, but as several years usually elapse after discovery before the field is sufficiently explored and developed to warrant the expense of laying extensive lines thereto, and the expense of transporting gas by artificial pressure is so great during the latter portion of the period, the usual successful commercial life of the field is reduced to from one-half to two-thirds the former limits.

Since the value of pipe and material reclaimed on lifting a line is worth above the cost of reclaiming only about one-fourth the original cost of the line, the charge for depreciation must be taken at least one-tenth of cost. To this must be added 5 per cent. more yearly for repairs during the period, making the total for depreciation and repairs from 15 to 20 per cent. per year.

Compressing Problems.—In the early stages of the natural gas industry the gas was conveyed to market by the initial or rock pressure of the wells. However, as the gas was depleted and the pressure waned other means were necessary to accomplish the result. To furnish this power has brought about the development of the modern gas compressor, which is among the most perfect of mechanical appliances.

A number of steam power stations have been built in which are the most improved types of Corliss cross-compound units of 1,000-horse power and more, directly connected to compressors capable of operating against pressures of from 250 to 500 pounds per square inch. These use natural gas as fuel and burn the gas with such economy that 1-horse power is maintained in the compressor cylinders with a consumption of but 18 feet to 20 feet of gas per hour.

Within the past 3 or 4 years gas companies have availed themselves of the efficiency of gas engines which transform natural gas directly into power within the cylinder. At present duplex engines of this character, in which the piston receives an impulse with the same frequency and regularity of a Corliss engine, have been constructed. These are directly connected to the compressing cylinders and have so increased the efficiency that 1-horse power can be maintained with an expenditure of less than 10 feet of gas per hour. A few problems in gas compression will be referred to.

The work in compressing per unit of time is:

W = pressure times displacement. Where the pressure is the mean effective pressure of the compression. This in isothermal compression is: $Mep = p_1 \times hyp \frac{\log op^2}{p_1}$, and in which p_1 and p_2 are the absolute intake and discharge pressures respectively.

$Q = \text{displacement} \times \frac{p_1}{14.7}$, or

$$\text{Displacement} = \frac{14.7q}{p_1}$$

Substituting the values of Mep and displacement we have

$$W = p_1 \times \text{hyp log} \frac{p_2}{p_1} \times \frac{14.7q}{p_1}$$

Cancelling p_1 and transposing 2 q, we have

$$\frac{w}{q} = 14.7 \text{ hyp log} \frac{p_2}{p_1} .$$

or, in compressing a given quantity of gas the work done is proportional to the hyp. log. of the ratio of the discharge and intake pressures, and if the intake pressure can be increased the discharge pressure may be increased in an equal ratio and the work remain a constant.

For example, the work of compressing from 15 to 60 pounds absolute, or from 0 to 45 pounds gauge, is the same in isothermal compressions as in compressing from 45 to 225 pounds gauge pressure. In actual practice, as the water jackets of the compressor do not remove more than half the heat set free, the compression is not isothermal, and the work is increased by approximately 10 per cent.

Since an increase in the intake pressure admits of an increase in the discharge pressure of equal ratio for the same work, it is evident that ultimate economy exists in so placing the compressing station that the intake pressure will be a maximum, which will be accomplished by placing it as near the field or well end of the line as is practicable. A further economy exists in that with high pressures the same quantity of gas can be passed through smaller cylinders, and, therefore, smaller and less expensive compressors are necessary. Also, the plant should be so designed as to discharge the gas at as high a pressure as is consistent with the safety and economy of the pipe line.

In designing the size of the compressing cylinders for a given service it is necessary that their size be such that the engine may be able to operate the compressor at the point of maximum load. This has been found to be when p_1 equals about one-third of p_2.

There remain for comparison the mechanical problems and the difficulties encountered in the operation of compressing plants. Up to the point where the power is delivered to the compressor in a steam driven plant, by means of a rod extendimg through the steam cylinder head, the problem was comparatively simple, being nothing more or less than a steam engineering problem, where the boiler, engine and auxiliary units, such as steam pumps, feed water heaters, condensers, etc., are arranged according to the particular requirements along the line of current steam engineering practice.

With the compressor, however, the problem was different, for new conditions have had to be met, and it has been only during the last few years that the compressor has reached any degree of perfection.

The solution of these questions is largely due to the steam engine indicator applied to the gas compressor. Through it the gas companies and engine builders who built the compressors came to realize the clearances which had previously been permitted in low pressure air work were absolutely prohibitive, when long ranges of compression were to be accomplished. In the most approved compressors of to-day the actual clearance is often as little as one-tenth per cent. Conical heads are used upon the cylinders with conical followers on the piston for the purpose of providing sufficient surface for the inlet and discharge valves, so that a sufficient number of the same can be located in the head and close to the cylinder, thus doing away with long ports from the cylinder to these valves. Where these ports exist clearances are introduced with a corresponding loss of economy, depending upon the number of compressions.

The actual clearances obtained, including that due to valve ports, and that portion of cylinder not swept through by the piston, amount in the best practice to less than 1 per cent. However, this multiplied by the number of compressions might be increased to 5 per cent. Sizes of valves, their weight and the percentage of valve area are also matters which have received attention.

The ratio of valve area to piston area which has been found satisfactory is about as 1 to 10 where a piston speed of 600 feet per minute is used. This causes the gas to pass through the valves at a speed of about 6,000 feet per minute. Where the valve area is restricted beyond this point, with a corresponding increase in the velocity of flow, throttling takes place with a resulting peak on the card and an increase of load with no more useful work accomplished. If the valves are made heavy they become slungish and slow in closing with an accompanying loss in economy. If they are made light the danger of breakage is introduced, which would be very serious if any of the parts found their way into the cylinder. With the small clearances, a piece of broken valve not larger than a hickory nut might cause the wreckage of a cylinder or entire side of an engine. All gas compressors are now provided with shields to prevent pieces of broken suction valves getting into the cylinders.

With discharge valves the danger is not so great on account of the type of valve which can be used, and the fact that the tendency for the part of a broken discharge valve would be away from the cylinder instead of into it.

The question of size of valves is also worthy of some consideration. In the early days large valves were used, which were heavy and cumbersome in action and the large lift necessary to give the required opening caused a rapid wearing of both valves and seats. Recent practice has reduced the diameter of valves to less than 3 inches, with a corresponding reduction in the lift.

Trouble is frequently caused from the sand and grit carried with the gas into the cylinders, and to take up the wear resulting from these, cylinders are sometimes made with removable cast iron bushings or liners which can be replaced at comparatively small cost.

Discussion.

The President—It is unfortunate that this interesting and valuable paper could not be printed so that you could study it more in detail. If, however, any of the members wish to ask for further information, Mr. Hammon no doubt will be pleased to accede to your request. The subject is before you for discussion.

Mr. McDonald, Louisville—Mr. Hammon has shown such an absolute knowledge of his subject, being able to even think in hyperbolic logarithms, that I hate to take issue with him on anything about which he is no doubt more familiar than the rest of us, but I want to know if I understood him correctly when he said that the cost of wrought iron pipe will vary as the square of the diameter? Now, the perimeter will vary as the diameter and the weight of metal will vary as the diameter, so I cannot think of any reason why the cost should vary as the square of the diameter.

Mr. Hammon—When the pressure that the pipes must hold is considered, the cost will be as the square of the diameter because the thickness of the pipe must vary as the pressure it will hold, and the cost being proportional to the weight, will vary as to the circumference multiplied by the thickness. The circumference is as the diameter and the thickness being as the diameter the cost will be as the diameter squared.

Mr. John Franklin—Respecting rubber joints I would like to ask Mr. Hammon regarding them. When he spoke of rubber packing for joints in cast iron pipe being much preferable to lead or cement I would like to inquire a little more in detail just what kind of a joint was referred to.

Mr. Hammon—Are you acquainted with the couplings used for piping natural gas at all?

Mr. Franklin—No, I am not.

Mr. Hammon—There is a coupling made in which is a center ring that acts as a collar inclosing the ends of the joints to be coupled and against which is pressed a rubber gasket. This gasket is packed into the crevice between the center ring and the pipe by means of flanges bolted together across the joint, thus preventing the escape of gas from the joint.

Mr. Doherty—Wouldn't it be a good thing for Mr. Hammon to keep track of all the questions propounded and then to answer them at one time?

The President—You may do that if you will, Mr. Hammon.

Mr. Shattuck—Mr. Hammon gives the amount of gas required to develop horse power in its most economical compressor. I would like to know from him how many cubic feet compresses per horse power. In a duplex, single acting machine it takes 1¼-horse power to compress 1,000 cubic feet; that is 1¼ per hour from zero to 30 pounds. I have figured on using rubber joints if we could only get a pipe about 30 feet long. It would then be practically as cheap, counting the rubber and all, as a screw-and-socket joint. But it is practically out of the question to get a 30-foot pipe. We have some rubber joints that have been in 4 years on an artificial gas main and have taken them up in increasing the size of the pipe and found them absolutely tight. We have only had one rubber joint that gave out, and in that instance we found that in putting it on it was pinched and was not screwed up properly. It was screwed up too tight on one side, leaving a chance for the gas to cut its way through on the other side. We found that the rubber caps on the inside of the pipe were eaten off by the oils in the gas and were carried along to our drips and services, plugging them up. The Dresser people got out an asbestos joint, or a joint which had an asbestos cap instead of a rubber cap, which seems to answer the purpose, although we have found some asbestos in the line which was probably torn off by friction resulting from particles of sand passing over the joint. With

reference to the question of electrolysis, it seems to be the opinion of many experts that it is a bad plan to cut the line up and insulate it. It is better to make it a continuous line, picking the current off at frequent places and carrying it back with one conductor to the power house. There seems to be a difference of opinion, however. I have so far used insulated joints, but I think there is more to be said on that subject and in the course of time the problem will be solved to the satisfaction of all. Mr. Hammon said with broken discharge valves the tendency was to fly away from the danger point. While I do not follow him in that, it seems, as soon as the suction stroke comes on, the back pressure is going to force the valve back on the cylinder. To guard against such trouble all of our valves now have a cage to prevent the broken parts from dropping into the cylinder.

The President—Mr. Hammon, if it suits you better, you may answer these questions as they are propounded.

Mr. Hammon—I will make a memorandum of the questions as they are propounded and answer them later.

Mr. Klumpp—I would like to know what provision they make to prevent a line from blowing out when they strike "L's" in exposed places? For instance, a pipe coming out of the ground and making a bridge crossing, there is apt to be either an "L" or a bend of some kind, and I would like to inquire what provision is made with a rubber joint to protect it? Then, also, if a long line was suspended from the bottom by a tie rod, whether there is any provision to anchor it and to keep it from buckling? In actual practice I would like to know if this buckling occurs, and if it does what course is pursued to prevent it?

Mr. H. A. Carpenter—Following the same line of thought, Mr. Hammon mentioned that under certain pressures and sizes of pipes it was necessary to have a deeper fill on top of the pipe to hold it in the trench. I would like to have some information from him as to what course should be pursued, for instance at large bends or where you changed the direction of your pipe line. Assuming that you have anchored it as it is necessary to anchor it, do you ever have any trouble with these bends exploding? Is there a calculation that has to be made on account of the radius of the curvature of the bend, or do you terminate one line directly into another? I would like to know just exactly how that is done, especially with pressures up to 300 pounds.

Mr. Whysall—I cannot see that we are saving any time in discussing these questions in this manner. I think it would be more satisfactory to let Mr. Hammon reply as the questions are raised.

The President—Mr. Hammon, we would be glad to have you do that.

Mr. Hammon—As to some of these questions perhaps I will have some difficulty in replying to them to your satisfaction. Regarding the amount of horse power necessary for compressing a certain amount of gas, of course, that depends upon the limits through which you are compressing. In a lift from zero to 50 pounds, we figure about 1,000-horse power to 10,000,000 feet of gas or 100-horse power to 1,000,000 feet of gas—lifting as I say from zero to 50 gauge pressure. That is a fair statement I think of the rule, and if you can reduce it to your particular condition you can determine from that what the result will be. Of course from zero to 25 it is not as big a piece of work; whereas from zero to 75 it is more. Your engine is doing the heaviest work when the absolute discharge pressure is three times the absolute intake; or to state it the other way, when the absolute intake pressure is about one-third of the absolute discharge. This rule must be worked out mathematically to suit different conditions. For different gases it depends upon the specific heat of the gases and their gravity.

Mr. Klumpp—Isn't it about 50 to 55 pounds for a heavy load, or an average of about 50 pounds?

Mr. Hammon—With 30 pounds discharge pressure the intake pressure that would make the load a maximum would be about zero gauge pressure. When you get to 50 pounds the maximum load will be 50 plus 15, making 65, and ⅓ of 65, or 22 absolute pressure, or 7 pounds gauge pressure. Now, as to insulated couplings with a rubber apron in artificial gas; of course, the rubber apron will be dissolved. I have experimented considerably, endeavoring to find the proper material for insulating artificial gas. The best method I know of is to coat it with some substance that is insoluble to the action of hydrocarbon on the inside of the center ring.

Mr. Carpenter—What has been the result of your experiments?

Mr. Hammon—It is pretty hard to say what that material is. I have made experiments with substances that make a sort of a stone coating. As to the relative merits of insulation and tying the pipe line to the bus-bar of the generator, it may look as if you have made an improvement, but I have serious doubt personally as to its being an improvement. Your pipe gets loaded with an extremely high current and every pipe of less voltage than your own that lies near yours, and every article, whether pipe or anything else with less voltage than your own, when it comes near your pipe line, will cause your pipe to be injured at that point. By the present method of putting the negative bus-bar to the ground you have this advantage, that the high pressure section of your line will be out and away from the power house and be scattered all over your system and thus divided up. But the actual results I think are much more serious. In working with gas heavily charged you are liable to have a fire and consequent injury by getting in contact with it. I have seen pipes where the workman was using a shovel, and by bringing it in contact with another pipe it would set up an arc and burn a hole in the pipe in a very short time and thus cause injury. Now, in regard to angles. Where you make too sharp an angle working under high pressure you have to anchor your pipe. That is the only thing there is to do if you are handling extremely high pressures and you make a sharp angle with a rubber coupling. It will stand about 150 pounds to the square inch before it will pull out, but when you go above that point you must anchor your pipe if you make sharp angles to keep the elbow from pulling away. In my work we use couplings that will admit of a small angle and we divide the angle up among a number of joints by making a small angle in each one, and thus the joint of pipe buried in the earth itself acts as the anchor. In going down I think it is wise to use a coupling that you can make a certain amount of angle with. Then there is no tendency towards buckling or strain of any sort. I think that also covers the question propounded by the gentleman with reference to explosion. I have seen many cases where there have been explosions due to the blowing off of a coupling, pulling the pipe apart on a bend. You have to put the pipe in the ground an extra depth when you are going to use very high pressures or a large pipe in order that it may stay there and not pull.

Mr. Doherty—I want to first explain why I suggested that Mr. Hammon wait and answer all of the questions at one time. That is a fixed rule with all engineering societies, and I think it has been the custom in the Ohio Gas Light Association. I know that it has prevailed in all the other Gas Associations. There is an advantage in it, I think; but in a paper like this, where so many questions are asked, the method which has been suggested and which has been followed in this instance is no doubt the better method, although I would hate to see it established as a precedent. I have been interested in the problem of electrolysis and I have heard a great many rules laid down. I know of no rule which is universally applicable except the rule to protect your pipes so as to prevent any current from leaving through an electrolyte. That is the only safe rule to follow That is a fundamental rule and you have to come back to it in any discussion on the subject or in any effort to remedy the trouble. In some cases you may find conditions are such that you may best protect your pipes by a metallic connection to the negative bus. Occasionally in using an insulated joint you simply make the same current leave the pipe any number of times and thus cause depreciation all through your line while you can have all of your current leave your pipe but once, and leave it at one point, it seems to me to be less serious than it is where it leaves it at hundreds of places and then comes back on the pipe, thus causing general depreciation throughout the entire city. You have more paving to tear up for one thing, and I have never seen a report on electrolysis where I thought the reporters analyzed their problem thoroughly. I do hold that there is no fixed law which is generally applicable. I was considerably interested in that portion of the paper of Mr. Hammon wherein he referred to the curtailing of the leakage on artificial gas mains. Take the best practice that now prevails and our leakage is considered to be great enough in the minimum, so that my figures would indicate that we could afford to spend $1,000 more per mile to make our lines tight or approximately tight. I think our practice with reference to distribution is in greater need of improvement than almost any other branch of the gas business. Mr. Shattuck has said that if he could get a pipe 30 feet long he could afford to use a joint similar to those used on natural gas mains. It seems to me he would closely approximate that condition by using an insulated joint and bolted joint between a flexible joint, if his pipe has strength enough and the character of the soil is such as to permit the contraction and expansion to be sent on to the flexible joint there to be taken up, and I believe it would be. I have never been in sympathy with the method of using a number of cement joints and then a lead joint. If you will figure on the power required to pull a pile it will indicate that the pipe will break before the expansion or contraction will be taken up by the lead joint, if it is possible to take it up by the lead joint. You must also remember that lead has no elasticity and you can easily compress it but it will not come back. There are a number of other matters which interest me in connection with Mr. Hammon's

paper. One was his statement that they used Professor Robinson's formula. I would like to ask him what records are available to substantiate these various formulæ and determine which one is accurate. I I would also like to suggest in this connection to Mr. Sbattuck that Mr. Hammon would probably give him more or less information in his committee work which would be of great value to the committee. Likewise would suggest to you. Mr. President—I do not make this as a motion —that the Committee on "Flow of Gas in Pipes" be increased to four, and that Mr. Hammon be induced to serve on that Committee. I was greatly pleased by the tone of Mr. Hammon's paper. It reminds me of a friend of mine who always expresses himself in slang, and he describes the different engineers he runs across by the use of the expression, "He is one of those fellows who talks in rag-time;" and when he strikes a fellow who is about half-way right he says, "He is a fellow who talks in two-four time." Using his form of comparison, I would say that Mr. Hammon has been talking to us in "four-four time." (Laughter and applause.) Mr. Hammon praised the gas compressor as a very perfect machine. My experience has been of all the poor pieces of apparatus on the market the worst was the gas or air compressor. He, however, is working under a condition where his compression, as I understand it, is only 3 to 1, and it is possible to get very good results from a compressor under those conditions. I wanted to ask him how much of a change in volume they permit on one stage compression and where they draw the line from one to two or more compression. I was also interested in the statement as to the small clearance he provides for his compressors, and would like to ask how he can figure out a maximum for 1 stage compression zero to 30 pounds, or changing the volume from 3 to 1 is all that is permitted with a compressor having as little clearance as he states. It seems to me the llmit of compression would be very much greater than 3 to 1. In some instances it is not uncommon to compress from 6 to 1 in a single stage compression. I was also interested in his statement with reference to the actual compression line between his isothermal and adiabatic. I do not know whether he gave the speed of the gas through the valves. I didn't hear it if it was stated, but I suppose if the paper is printed we can refer to it in that way.

Mr. Hammon—Six thousand feet per minute.

Mr. Doherty—I was also interested to know whether they use a compressor with mechanical valves or automatic valves? I would also like to know how large a piston they think it necessary to put a tail rod on. In a general way, Mr. President, I think this paper is a particularly valuable one. I predict in the next 5 years there will be very pronounced changes in our present methods of distributing artificial gas, resulting especially from our efforts to secure tighter lines with less leakage on them, and I think we can learn a great deal from natural gas people on this subject. I am also greatly pleased to know that this meeting of the Ohio Gas Light Association has shown a disposition to bring in and secure the benefits and experiences of the power engineer and the natural gas man, and to know that there is one organization at least where gas engineers of all sorts can get together and exchange experiences and secure the benefits which result from such knowledge and experience.

Mr. Hammon—I was rather surprised at the statement that the equal economy between a bowl and spigot joint and coupling joints would be about 30 feet. I presume you used cement in your work.

Mr. Shattuck—I referred to wrought iron pipe, not to cast iron pipe.

Mr. Doherty—I did not say cast iron, did I?

Mr. Shattuck—I meant wrought iron couplings.

Mr. Hammon—You compared the economy of a 30-foot joint with a rubber coupling, with what? A 30-foot joint with rubber coupling was equal to what?

Mr. Shattuck—We used rubber couplings once in say 500 feet, while you use them on every length, and if we could have a 30-foot wrought iron pipe, I figured that the saving in labor would make it as cheap for us to use rubber joints once in 30 feet as it would be to use them as we now use them. We could do it equally as well as to use a screw pipe.

Mr. Hammon—Do I understand you to say that you use screw pipe and then put them on that often?

Mr. Shattuck—Yes.

Mr. Hammon—I would like to take the contract of laying your line with rubber couplings and make it stand equally as long and not charge you 1 cent more than your screw line. I can use a little lighter pipe which would more than compensate for the increased cost of couplings. I will not weaken it by cutting the threads in it. I will lay it so that it will last longer because in laying a screw pipe when you screw it up with your tongs you leave marks in the protecting coating that will have to be repaired. I will lay it so much cheaper that, adding the increased cost of the rubber couplings, I will still be ahead, taking the contract at the same price as you would pay for screw joints. I will also guarantee that you will have a better job after I am through than you will have if you follow the method you have been following.

Mr. J. T. Lynn—What kind of a coupling will you use?

Mr. Hammon—A rubber coupling.

Mr. Lynn—What joint?

Mr. Hammon—If I had the contract I would use the Hammon coupling, but you can accomplish the sume result with a Dresser or a Dayton coupling. I think we better leave the discussion of insulation until everybody has spoken on that subject. Of course, there are a great many ideas as to what is best in insulating. This paper does not especially refer to it, but as it is a subject that has been very interesting to me, of course, I have my own opinion about it. I also appreciate the fact that others may have different opinions. Now, I did not mean to say at all that in compressing gas the most economical point of second stage was at 30 pounds. I meant to say that at 30 pounds discharge pressure the maximum work would be performed when you were taking your gas in at zero, but in actual practice in second stage compression we usually take it at about 50 pounds; the first stage compression takes it from zero up to 50 pounds, and the second stage from 50 to approximately 300. In actual use in natural gas service our wells at first supply all our pressure. Then as the pressure depletes, if we need 300 pounds to carry enough gas through our lines to supply our market, and the well pressure will not maintain 300 pounds on the line, we put on a compressor that will take it at any intake pressure from 50 up to 300 and discharge it at 300 pounds and we keep taking it at the varying intake pressures from that time on until our field will only supply the required amount at 50. Then we install other compressors that will take it in at any intake pressure from 50 down to zero and operate them in conjunction with the first compressors with an intercooler between. As to actual experience in compression regarding how closely we approximate the isothermal curve and how nearly we approach the adiabatic I should say we approach a curve about one half between each. That is a rough approximation. It is about half-and-half way between the isothermal and the adiabatic. I think the best results in gas compressors are to be obtained from the use of automatic valves rather than the mechanically operated valves. We have gone through the experimental stage so far as mechanically operated valves are concerned and our experience has not been very satisfactory. They get out of order and shut us down more frequently than the poppet valve. We use a very small poppet valve and by using a conical head on the cylinder we get a larger area and a stronger cylinder than after we have bored a flat cylinder to put in an equal number of valves and it has necessarily been very much weakened. We have a larger area by using a conical head and get plenty of valve area and also plenty of strength in the cylinder head by that means and a very small clearance. By using a small valve you can make a smaller clearance than you can by using a larger one.

Mr. Shattuck—One more question. Is there the same tendency in natural gas to gum the valves as in artificial gas?

Mr. Hammon—Not unless it carries sulphur.

Mr. Shattuck—In artificial gas there is a considerable tendency to gum the valves and we have used oil to try to overcome it. Our experience is that the mechanical valve is better for artificial gas than the poppet valve.

Mr. Norris—Mr. Hammon spoke of using couplings on ordinary cast iron joints, and I understood him to say that there were certain incidental disadvantages in first construction. I would like to know just what those disadvantages are, if he had anything more definite in mind aside from the cost.

Mr. Hammon—I did not oppose the use of rubber couplings for cast iron pipe, but the use of a clamp on top of the bowl and spigot pipe. If I were laying a new line it could be done more economically by discarding the bowl and spigot joint and using ordinary rubber couplings. The pipe will cost about the same in one case as the other, so that comparing the two in cost you have the cost of the bowl and the lead to compensate for the cost of couplings.

The President—I would like to say that many artificial gas men as a general thing do not appreciate the use of the flexible rubber coupling. We have an idea it costs us much more to lay a line that way than it does otherwise. I had an experience this last year. I laid as a test about 2 miles of 8-inch line, using the ordinary weight pipe. I wanted to use that weight because I wished to tap service pipes directly into the line, so did not wish to use a thinner pipe. I used the Hammon coupler. The cost of the pipe plus the cost of the couplings was about 7½ cents more than I would have to pay for the ordinary screw pipe.

The cost of laying the line, digging the ditch, laying the pipe and the filling was less than 8 cents per foot. I figured we saved enough on that work to pay for the extra cost of the couplings. In addition to that I eventually got an absolutely tight line. When I first turned the gas into the line at 30 pounds I had a leak that was caused by a cracked center ring in a coupling. We dug that out and replaced it with one that was all right, turned the gas in at 30 pounds and left it stand for—I don't remember how many days now; but I have a record of it at the office. There was no depreciation in pressure at all and no leakage on the line as far as I could see. We went very carefully over the line afterwards and took all the precautions we could take to ascertain whether there was any leakage, because I was afraid when I came to actually use the line it would be in the winter time and I would not be able to find any leaks if we had them. I wanted to find whatever leaks there were before we really needed the line. I was very careful about that and after inspecting and examining in every way we could we did not find any leaks and I do not think there were any.

On motion a very hearty vote of thanks was tendered to Mr. Hammon for his very valuable paper, and to emphasize the appreciation of the Association the expression of thanks was taken by a rising vote.

The President—Gentlemen, with the consent of the Association I will increase the membership of the Committee on Flow of Gas in Pipes to four and we will try and prevail upon Mr. Hammon to help us on that Committee.

[To be Continued.]

When Large Cities Will Have Cheap Electricity.

Electricity, writing in answer to the query, remarks: Agitation and legislation cannot effectively alter the actual cost of electricity: They may impose restrictions, through which a fancied relief is obtained, but the three great fuels of mankind, coal, oil and wood, will still be charged for at a rate which nets a reasonable margin of profit to their owners. The State recognizes the impossibility of imposing its will upon industrial enterprises whose business methods are clean in this respect. It cannot force concerns to sell coal or oil or wood at a loss, and, therefore, it is in many respects similarly situated with regard to those corporate interests self-intrusted with the great municipal responsibility of supplying electricity for lighting the city streets. These facts are known to be applicable, not only to specific instances where public sentiment has cried out against extortion, but to the great majority of cases where electricity performs this public service.

Therefore, the absolute cost of fuel and the cost of the complete electric light installation are, in the aggregate, the sources of expense—the one permanent, the other continuous—upon which are based the charges for electricity. If the fuel charges are reduced to figures admittedly fair by the purchasers, and the installation of a central station and its many accessories is laid down on such economic lines as those best justified by the opinions of the most competent of engineers, then the outlay has not been excessive and it is necessary to consider the financial conditions involved, which must be the cause of such prices as are charged for electrical energy. These, in detail, cannot be adequately reviewed without special provision being made for many pages of statistics. Yet the general reasons may be briefly presented in conjunction with those that will indicate the time when large cities will have cheap electricity.

Among those that may be presented are such as refer to the earlier experimental period of electric lighting, that time during which the system required creation. Plants were constructed and reconstructed, and the entire lower section of New York was covered with an expensive underground network of wires. The earlier history involved heavy expenditures, which partly composes the debt of older companies in the lighting field. Much money had to be sunk before success came, in the shape of enough consumers of current to found the basis of an assured industry. The details, which in the end will constitute the complete elements of a great plant, are not as yet all perfect. Every half decade or decade sees changes of a most important nature. And it can be readily understood that with the swift advance of new devices in the field of electric lighting, the new additions will make as marked a transformation in the central stations of 10 years hence as those of 10 years ago have made in the present.

While it may be added that over-capitalization also adds its load of financial responsibility to the shoulders of those promoting the interests of electric lighting, frequently this is done in anticipation of a natural industrial growth and for this reason becomes absolutely legitimate. When this is carried on to excess, however, and the dividends that must be paid on watered stock constitute a burden to the community in the way of overcharges for current, it is quite evident that radical measures must be taken to modify such conditions and transfer the load to where it properly belongs.

Large cities will have cheap electricity if the great natural sources of power are employed whose utilization would result in low prices and efficient lighting and heating for even the most humble.

It would be very much better to burn coal at the mines and transmit electricity to New York at high pressure than ship coal here by steam roads for the same purpose. No well-constituted body of electrical engineers would refuse to entertain this idea seriously. On the other hand, water power in the Appalachian and Rocky Mountain ranges for the inland towns, and Niagara toward the north, would supply large amounts of power for industrial purposes. A system of tide motors highly developed has shown great efficiency at several points on the Atlantic and Pacific coasts in the last few years. It may not be too much like unwholesome anticipation to predict the erection of trunk power lines carrying the electrical energy for whole States in the near future. Such a public necessity like light deserves just as much consideration as pure water or fresh air. It will be only a question of time before this idea will burrow its way into the minds of the general public, whose wish in this land is law.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, ENGLAND, April 10th, 1905.

A Businesslike Association.—The 5 Cubic Feet Fetish.—The Stethescope as an Aid to the Gas Works' Manager.

The Isle of Wight Gas Association cannot boast of a large district or a large number of members, yet it is no empty compliment to say that the lack in quantity is compensated for in the matter of quality. The area of the Island is not extensive, perhaps about 200 square miles, and the number of undertakings concerned is under a dozen, yet the Association, which was formed in the autumn of 1903, and has just held its first annual meeting, having for its object the promotion and advancement of the various movements connected with the gas industry of the Isle of Wight, as well as the discussion and consideration of matters of professional and commercial interest, has acted well up to its title. That it is no mere kid-glove and easy-chair, 3 days-a-year society, with half the time devoted to the social element, is shown by the fact that during the 19 months concerned, 10 general and 10 committee meetings were held, at which many matters were discussed. These included the best means of advertising as a counterblast to the efforts of the electric light interests, the sales of residual products, and the arrangement of important installations of gas lighting in public buildings. Handbills and post cards were distributed and a public challenge as to the relative costs of gas and electricity was issued to the Electric Light and Power Company, who declined to take it up. This is no matter for surprise, as it is notorious that while electricians make all sorts of claims as to the "cheapness" of electricity, they do not care to force a plain statement of fact. They prefer vague generalities, or some roundabout argument that "no fellah can understand." As the result of the action of the Association the prices of residuals have been assisted. Improved gas appliances have been introduced, and the services of a canvasser, whose time will be apportioned between the members, have been retained. A notable feature was the presence of several directors at the meeting. The want of sympathy between the directors' board room and the gas associations, has frequently been lamented, and perhaps the best way of removing it is for the latter to justify their existence. An argument of the better price for coke costs is likely to go further than any amount of eloquence.

There is the more need for action of the nature taken by the Isle of Wight Association, in view of the fact that strenuous efforts are being made by electricians in the way of pushing business. Their capital expenditure is heavy, and any loss of existing or of prospective business, such as that brought about by the increased use of gas for incandescent lighting, must touch them on the raw. Arrangements have been made for a National Exhibition on the lines of the Earl's Court Exhibition, to be held in London in the autumn, and in addition to this an ingenious device has been hit upon for the small provincial towns. A large public hall is engaged for a week and fitted up with an attractive show of various applications of electricity, an illuminated fountain and other marvels. The same is very well advertised, together with an announcement that while a small charge is made for admission, the whole of the proceeds, without any deduction for expenses, will be handed to the principal local public charity. As a result of this double barrelled combination of philanthropy and business, a good advertisement is obtained at a very moderate cost. The chairman of the Institution

selected to receive the gross proceeds, is of course delighted to open the show in person, and to give it a good send off. And as he is a person of some influence and standing in the district, usually possessed of a handle to his name, this of itself is no mean advantage. Many individuals are thus inveigled into what is to all intents and purposes, however artfully disguised, a show room, sale and order department of the company. The old proverb of the spider and fly is again illustrated, as astute salesmen are in attendance to make the best of the opportunity.

Someone has remarked in reference to the motto, *Magna est veritas*, that a right down deliberate lie, well stuck to, will run it pretty close. Such is evidently the opinion of the electricians, for notwithstanding the preponderance of evidence, both theoretical and practical. they persist in statements to the effect that electricity is cheaper than gas. In 1876 it was announced that the Edison light would be one-tenth the cost of gas, and in one form or another the same old yarn is still put out and persisted in. They ignore the fact that many, like the parson who found honesty to be the best policy, have tried both, and have made no secret of the result, and that local authorities, even aganst a sneaking predilection for their own electric light works, are compelled to own that incandescent gas light is the cheaper. Several other statements advanced in the interest of electric companies are more remarkable for plausibility than accuracy, and there is a notiecable evasion of any reference to the incandescent gas light. A statement addressed by a clergyman in Nottingham to the editor of a local newspaper probably furnishes the reason for all this flutter. He says: "The use of incandescent gas instead of electric light for our choir has resulted in the electric light account for last Christmas being £2-15-7 instead of about £7 the previous Christmas. We get a better light and the only murmur I have heard is that the whole church is not yet lighted with gas mantles." This experience is not confined to Nottingham.

I have already directed attention to the extraordinary conclusions arrived at by the Department Committee appointed by the House of Parliament to inquire into the question of standard testing, to the effect that one burner—Sugg's No. 1 Argand—one chimney 6 by 2 inches, and one rate of consumption—5 cubic feet per hour—should be used for testing all qualities of gas. The decision has already been referred to in connection with the Parliamentary Committee work of the present session, and it is evident, from a letter written by the President of the Institution of Gas Engineers to the *Journal of Gas Lighting* and *Gas World*, that the representative body of the gas industry does not intend to sit down quietly under such an infliction. Mr. Irving remarks that the Institute have already memorialized the Board of Trade in reference to the very unjust methods of testing of gas for illuminating power that is recommended by the Committee, and that a paper on the Committee's report has been promised for the next meeting of the Institution, by Mr. C. Carpenter, the Chief Engineer of the South Metropolitan Gas Company. Every opportunity will be afforded for discussion and for taking further action if thought desirable. The Committee do not say what is to be done in the case of a 20-candle gas, which, burnt in the No. 1 Argand at the 5 cubic foot rate, would yield more lampblack than light and render the operator "sootable" for taking the part of Othello the Moor without further makeup in the matter of complexion, probably because their attention was divided to the other end of the scale. The tendency is towards lower illuminating power, and they, therefore, investigated the effects as regards lower qualities. In respect to these they admitted that the 5 cubic foot rate would prejudice the companies to some extent. But the answer to this was that it did not matter, as all that was wanted was to give the gas a name. They said in effect that it did not matter if a 14-candle gas was in future known as a 13-candle. It would not matter, perhaps, if a sovereign was held to be worth only 19 shillings—to the parties who hold all silver. But what about the rights of those who hold all gold? This exactly represents the position as regards the public and the gas companies. If you tell a consumer that, although the gas is called 13-candle it is really 14, will he believe it? He will, figuratively, if not actually, "put his thumb unto his nose and spread his fingers out." The custom in regard to photometrical value has been established for half a century, and it is the value that is indicated when the gas is burnt by the best available methods open to the use of the consumer. No laboratory fakement would pass muster, but it must be such appliances and methods as could be adopted by any customer in any room or shop. This is what is understood as the standard photometrical value, and now the Committee propose to substitute something else, and apparently impressed by the quotation, "A rose by any other name would smell as sweet," they say it does not matter. But as a question of sentiment alone it is of importance. The electricians would probably resent a Parliamentary recommendation that a 16-candle glow lamp should be known as a 14-candle in the future. But the matter does not stop at sentiment. Questions of price and dividend are based upon photometrical value, and in connection with these it is obvious that if the recommendation is accepted a rise would be taken out of the gas companies to the extent of 1 or 2 candles value, or whatever the difference between the new 5-foot notion and the fair test as hitherto recognized may be. The 5 cubic foot fetish has already cost gas companies, and through them the consumers, thousansd of pounds with no compensating benefit to either. The consumer in particular knows little about it and cares less. All he wants is a good light at a cheap rate. And he might well exclaim, in regard to the question of testing for illuminating power—save me from my friends. Official testing was all very well while gas practically held a monopoly, but is quite unnecessary when the consumer has the choice of several other agents. It is perhaps a compliment to the importance of gas that it should be so carefully regulated, while other things are absolutely uncontrolled, but in common fairness gas should be allowed as much freedom as oil, candles or electricity.

A novel suggestion has been put forward by Mr. J. Napier Myers, of Saltcoats. He remarks that since the whole operation from the retort to the gasholder is of necessity carried on in closed vessels, one must depend upon imagination to some extent for a knowledge of what is going on. Much assistance may be derived by the use of a stethescope as used by medical men for the purpose of taking soundings at the retort lids, the exhauster, washer, meter, etc., as with a little experience it is possible to become as familiar with the working sounds when in normal condition, as a doctor does with the working of the human heart. It has been suggested that in the absence of a proper medical appliance the trumpet of a gramophone is an efficient substitute. The probability is that every gas works superintendent depends to a greater extent than is evident at first sight upon the assistance afforded by his ears, in maintaining an efficient supervision of the operations. When out of sight but within hearing, it is quite possible to follow the progress of any particular charge in the retort house. But so far it has been usual to depend upon unassisted hearing. Now it appears that in addition to spectacles and magnifying glasses for the sight there will be a trumpet for the ears. At present smelling, tasting and feeling have to go without crutches, but perhaps with the advancement of science some artificial aids may be found for them also, and when all is complete the gas manager with his paraphernalia will be an object of admiration to the scientist and of terror to the evil disposed on the staff.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE New York and Queens County Gas Company, of Flushing, N. Y., has awarded to the Gas Machinery Company, of Cleveland, O., a contract for an important purifier installation.

MR. HOWARD S. BOOTH, of Burlington, Vt., has been appointed Superintendent of the new plant in Bennington, Vt. Mr. Fred. J. Sisco succeeds Mr. Booth at Burlington.

MR. R. W. MOORE, formerly in the employ of the North Shore Gas Company, Waukegan, Ills., has been put in charge of the office force of the Wausau (Wis.) Company.

ADVICES by way of Grand Rapids, Mich., are to this effect: "Some months ago the common council of Belding, Mich., granted a 30-year franchise to Henry J. Leonard to operate a gas plant there. Some days ago articles were filed with the Secretary of State incorporating the Belding Gas Company, with Henry J. Leonard named as President and General Manager, and Mr. Walter S. Lambertson as Secretary and Treasurer. A site has been secured and Mr. Edward F. Gallagher, of Ionia, has been engaged to superintend the construction of the plant, which it is said will be completed by September 1st.

MESSRS. JOHN B. REYNOLDS, A. A. Holbrook, John B. Price and C. R. Troxell, of Wilkes-Barre, Pa., have purchased the Stroudsburg (Pa.) Gas Company. The concern supplies gas in Stroudsburg and East Stroudsburg. It also controls the water service in and to the named towns.

MR. THOMAS E. WALSH, Superintendent of the Catskill (N. Y.) Gas Company's works since 1890, has resigned that post in order to assume charge of the plant of the Saugerties (N. Y.) Gas Company.

THE Municipal Council, of Venice, Italy, has determined to purchase the local gas property and to hereafter operate the same on municipal account.

A SPECIAL meeting of the shareholders in the Pekin (Ills.) Gas, Heating and Manufacturing Company, will be held the afternoon of the 10th inst. The object of the meeting is to amend the Company's corporate title.

AT the annual meeting of the Derby (Conn.) Gas Company the officers elected were: Directors, Royal M. Bassett, Thomas Wallace, C. E. Clark, D. S. Brinsmade, Frank E. Hoadley, Chas. F. Brooker, Chas. N. Downs, Albert W. Philips and Charles H. Nettleton; President and Treasurer, Chas. H. Nettleton; Vice-President, C. E. Clark; Secretary, George H. Scranton.

A CORRESPONDENT in Hartford, Conn., forwards the following: "Judge Robinson, of the Tolland County Superior Court has appointed Walton J. Warner, of Branford, Conn., permanent receiver of the Stafford Springs (Conn.) Gas and Electric Company. A temporary receiver was named several weeks ago, and now the appointment is made permanent. The finances of the Company have been unsatisfactory for a considerable time, and the embarrassment became so acute that payment of interest on outstanding bonds was defaulted. The Company's plant is dilapidated and it will require considerable expenditure to put it in good condition."

THE resignations of H. D. Waldridge and A. G. Hodenpyl from the directorate of the Grand Rapids (Mich.) Gas Light Company have been accepted. Messrs. William H. Anderson and Henry Sullivan are their successors.

THE annual meeting of the U. G. I. Company will be held in the home offices at noon to-day.

MR. F. H. CORSON has resumed the position of Superintendent to the Winnepesaukee Gas and Electric Company, of Laconia, N. H. He seems to be the right man in the right place.

MR. FRANK D. MOSES has been awarded a contract to furnish and erect complete, at Spokane, Wash., two 12 feet by 24 feet by 8 feet deep purifiers. The Moses system of reversing valves will be used. Mr. F. H. Shelton is the constructing engineer.

MANAGER CONROY, whose clever handling of the New York offces of the General Gas Light Company, of Kalamazoo, Mich., has made many new friends for him, informs us that the Company has changed its Eastern headquarters from 54 Warren street to 46 West Broadway. The export trade of the Company has increased so rapidly, and its general Eastern trade as well, that the Warren street quarters were all too cramped. In the West Broadway location the Company has certainly placed itself so that its wares and goods may truly shine. The ground floor will be occupied by the general offices and a handsome showroom; the latter division, of course, will be given over to the display of a complete line of Humphrey lamps, flashlight signs and other goods. A feature of the floor line is a "Visitor's Corner," in the precincts of which will be found all the paraphernalia of a secretary's den—desk and material for desk equipment, almanacs, directories, telephone, railroad guides and the like. The location is an excellent one on the score of convenience, for within easy, in fact "next," distance, surface, subway, elevated and ferry transportation are at the command of the Company's patrons.

A CORRESPONDENT in Detroit, Mich., writing under date of April 22d, says: "Mr. Samuel Ball, Assistant Superintendent of the Jackson (Mich.) gas works, has accepted the position of General Manager of the La Porte (Ind.) Gas Company. Mr. Ball graduated from the University of Michigan in 1903, and held worthily for the appointed time the Gas Scholarship maintained by the Michigan Gas Association. His successor at Jackson has not been appointed, at least up to this date."

MR. L. E. CURTIS is to have charge of the new plant that is being constructed at Negaunee, Mich., by the Marquette Gas and Traction Company.

THE Bilbro plan for the constrnction and operation of a gas plant at Gadsden, Ala., does not seem to be making much headway.

GOVERNOR PENNYPACKER, of Pennsylvania, has vetoed the legislative measure authorizing the boroughs of the State to manufacture gas for the purpose of supplying themselves and their inhabitants with light, heat and fuel, and for such purpose conferring the right of eminent domain. The Governor in his ambiguous memorandum accompanying the veto, remarks that this is an instance of improvident and improper legislation and explains that in its passage the bill was so amended as to take away from the boroughs that which they already possessed.

MR. P. F. ROOHAN, Superintendent of the Saratoga, Springs (N. Y.) Gas, Electric Light and Power Company, has been appointed Manager of the light and power division of the Hudson River Water Company for the distributing stations operated by the Company between Glens Falls and Albany.

THE entire property of the Watkins (N. Y.) Gas and Electric Light Company were sold at auction recently to Mr. M. L. Driesbach, of Easton, Pa., at his bid of $7,500. The purchaser represented the bondholders. The claims of all kinds against the Company are said to aggregate not less than $108,500.

THE regular quarterly dividend of 2½ per cent. on the shares of the Municipal Gas Company, of Albany, N. Y., is payable to-day.

MR. WILLIAM FINDLEY BURNS, for quite on to half a century prominent in the business history of Baltimore, Md., died in that city a fortnight ago. He was in his 86th year, having been born in Baltimore, January 13th, 1820. In 1871 he was elected President of the Peoples Gas Company, of Baltimore, remaining as such until that celebrated opposition concern was merged with the Consolidated Gas Company, of Baltimore, in 1880. He was a Director in the latter at the time of his death. He was also largely interested in the affairs of the Consolidation Coal Company.

THE Mella Brothers, of Torrington, Conn., have been awarded the contract for the distributing gas mains that are to be placed this summer in Bristol, Conn., by the Bristol and Plainville Tramway Company.

AT the annual meeting of the New London (Conn.) Gas and Electric Company the executive management named was: President, James Hislop; Vice-President, B. P. Learned; Secretary, J. T. Bushnell; Treasurer, A. M. Young.

IN the argument made by the proprietors of the Lynn (Mass.) Gas and Electric Company before the State Board of Gas and Electric Light Commissioners, for the right to issue $230,000 additional capital stock, no one appeared in opposition. The cost of the new holder, in complete working order, is put at $155,000.

A COMPLETE reorganization of the gas, electric light and street railway properties of Baton Rouge, La., has been arranged for.

MESSRS. LIDDON FLICK, R. J. Flick, Morris Williams and A. M. Williams have applied to the State authorities for the right to operate a gas works "to be called the Gas Company of Salisbury township, the character and object of which are the manufacture and supply of gas for light only to the public in the township of Salisbury, Lehigh county, Pennsylvania, and such persons, partnerships and corporations residing therein or adjacent thereto, that may desire the same," etc.

MR. A. S. HALLE, formerly connected with the new business department of the Denver (Col.) Gas and Electric Company, has accepted a position with the new business department of the Consolidated Gas Company, of New Jersey.

THE shareholders of the Holland (Mich.) Gas Company, which was recently taken over by local capitalists, have elected the following Directors: G. J. Diekema, Geo. E. Kollen, A. C. Keppel, B. D. Keppel, J. G. Van Putten, John Besman, I. Marsilje and R. N. de Merelle; President, J. G. Van Putten; Vice-President, George E. Kollen; Secretary and Treasurer, I. Marsilje; Manager, R. D. Keppel.

MR. J. E. SHIBLEY, for some time Superintendent of the gas plant at Middletown, Pa., is now in the service of the Consolidated Gas Company of this city.

THE following from a recent issue of the Springfield (Mass.) *Republican*, from President Tenney, of the Springfield Gas Light Company, explains itself: You have noticed in the papers an item to the effect that beginning with July 1, the net price of gas in the city of Springfield will be 95 cents, and the Directors, in making this, have provided that the following clause be placed on all bills sent out by the Company: "The price of gas is $1.10 per 1,000 feet, with a discount of 15 cents per 1,000 feet if paid at the office of the Company on or before the 10th day of the month in which the bill is presented. Meter rent of $7 per year will be charged consumers whose bills do not amount to $7 per year." To show clearly how this meter rent will operate we will say that during the year all bills will be sent out monthly, showing the consumption per consumer, and in the month of August, annually, we will go over our accounts, and those burning no gas will be charged $7, while those burning and paying for a less amount than would equal $7 for the year will be charged in addition the difference between that amount and $7. It is not our desire to be arbitrary in this matter of the meter charge, and we will request all of our customers using several meters to consolidate them, as far as possible, and the cost of this consolidation will be borne by the Company. Under this arrangement the city will be able to purchase gas at as low a rate, freight charges considered, as any other city in this commonwealth.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

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NOTIFICATION RESPECTING ADVERTISING.
Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

MONDAY, MAY 1, 1905.

The Market for Gas Securities.

There wasn't any fair market for gas securities of the local sort this week. The whole transactions were of the short-and-long trading sort. Consolidated closed before the holiday (this year it was shared by gentile and jew) at 199¾ to 200, but the following Monday Consolidated sold at 204, next day at 206¼, then Wednesday's work showed a bit of a loss and bad Thursday, sent the price to 200. This day (the next Friday) some rejuvenation appeared, in that Consolidated closed at 202 to 203, in spite of the fact that the legislative committee left New York on the Empire State Express, carrying with it its digest and recommendations—that is, the committee members who were able to travel on that train were taken by it. The committee had a bad night in arranging for that which is to have the consideration of their colleagues. We think it is truth to state that the Company will tolerate no unreasonable interference with prices.

Brooklyn Union is weak when it should be strong, but the Brooklyn sagging is likely owing to non-support. We believe, however, that people conversant with the situation will not "short" the Brooklyn shares. Peoples, of Chicago, without any cause, has been battered to 104⅛ to ¼, and Baltimore is unchanged. Laclede, prefered, is 100 bid. Gas bonds are still inquired for at holders' figures, even some of the odd "New York and East River's" attracting attention. A fair quotation for Detroit City looks like 85 to 90.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.
16 WALL STREET, NEW YORK CITY.
MAY 1.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	202	203
Central Union, Bonds, 5's	3,000,000	1,000	108½	110
Equitable Bonds, 6's	1,000,000	1,000	..	103
" 1st Con. 5's	2,300,000	1,000	118	120
Mutual	3,500,000	100	300	320
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co.. Bonds, 5's	11,000,000	1,000	112	113½
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	35	
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	..	.	
Northern Union, Bonds, 5's	1,250,000	1,000	104	106
New York and East River.. Bonds 1st 5's	3,500,000	1,000	112	114
" 1st Con. 5's	1,500,000	..	106½	108½
Standard	5,000,000	100	125	130
Preferred	5,000,000	100	145	155
Bonds, 1st Mortgage, 5's	1,500,000	1,000	116	117
Yonkers	999,650	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	200	208
" " Bonds (5's)	15 000,000	1,000	113	115
Bay State	50,000,000	50	¼	⅜
" ncome Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	28	30
" 1st Mtg. 5's	509,000	1,000	93	96
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	6	7
" " Bonds, 5's	5,250,000	1,000	66	68½
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas and Electric Co	29,500,000	100	107½	108
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	97½	99
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	88¼	89¼
Preferred	3,026,500	100	107½	109
Consumers, Toronto	,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	88½	90
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
" Con. Mtg. 5's	880,000	1,000	89½	92
Bonds	75,000	..	..	100
Detroit City Gas Co	1,825,500	50	..	50
" Prior Lien 5's	5,603,000	1,000	85	90
Detroit Gas Co., 5's	381,000	1,000	75	80
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	39	40
Fort Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	..	104½	105½
" Bonds, 5's	10,500,000	..	107	108
Indianapolis	2,000,000	..	70	75
" Bonds, 6's	2,650,000	..	106½	108
Jackson Gas Co	250,000	50	82	..
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	..	90
Preferred	2,500,000	100	100	105
Bonds	10,000,000	1,000	108½	109
Lafayette Gas Co., Ind	1,000,000	100	..	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas & Elec. Co. " 1st Mtg. 6's	350,000	1,000	107½	108½
" 6 per cent. scrip, due 1910	100,000	25	85	87
Montreal, Canada	2,000,000	100	218	218¾
Nashville Gas Lt. Co.	1,000,000	100	110	..
Newark, N. J., Con. Gas Co.	6,000,000	..	56	58
Bonds, 6's	4,600,000	..	105	105¾
New Haven	2,000,000	25	200	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	104⅝	104¾
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	
Rochester Gas & Elec. Co..	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	15,800,000	100	58½	58¾
St. Joseph Gas Co. " 1st Mtg. 5's	751,000	1,000	94	96
St. Paul Gas Light Co	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	113	115
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	92	93
Syracuse, N. Y.	1,975,000	100	50	55
Bonds	2,047 000	1,000	102	..
Washington, D. C	2,500,000	20	340	342
First mortgage 6's	600,000	..	..	..
Western, Milwaukee	4,000,000	..	..	..
Wilmington, Del	600,000	50	230	..

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The Gas Machinery Co., Cleveland, O 700
The Western Gas Construction Co., Fort Wayne, Ind 720

GAS METERS.

American Meter Co., New York and Philadelphia 719
Detroit Meter Company, Detroit, Mich 719
D. McDonald & Co., Albany, N.Y 717
Helme & McIlhenny, Philadelphia, Pa 719
John J. Griffin & Co., Philadelphia, Pa 680
Keystone Meter Co., Royersford, Pa 718
Maryland Meter and Mfg. Co., Baltimore, Md 718
Metric Metal Co., Erie, Pa 719
Nathaniel Tufts Meter Co., Boston, Mass 718
Pittsburgh Meter Co., Pittsburgh, Pa 717

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D. McDonald & Co., Albany, N. Y..... 717
Helme & McIlhenny, Philadelphia, Pa..... 719
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Keystone Meter Co., Royersford, Pa..... 718
Nathaniel Tufts Meter Co., Boston, Mass..... 718
Pittsburgh Meter Co., Pittsburgh, Pa..... 717

PREPAYMENT METER ATTACHMENTS.

Reeves Mfg. Co., New Haven, Conn..... 712

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Davis & Farnum Mfg. Co., Waltham, Mass..... 712
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R. D. Wood & Co., Philadelphia, Pa..... 714
Warren Foundry and Machine Co., New York City..... 704

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H. Mueller Manufacturing Company, Decatur, Ills..... 702

CANNEL COALS.

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C. W. Hunt Company, New York City..... 704
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G. A. Bronder, New York City..... 709
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 712
The Brown Hoisting Machinery Co., Cleveland, O..... 711
The Gas Machinery Co., Cleveland, O..... 700
The Jeffrey Manufacturing Co., Columbus, O..... 710
The Link-Belt Engineering Co., Philadelphia, Pa..... 701
The Link-Belt Machinery Co., Chicago, Ills..... 6 6
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Sun Company, Pittsburgh, Pa..... 711
The Sun Oil Co., Pittsburgh, Pa..... 711

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Green Fuel Economizer Co., Matteawan, N.Y..... 696

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The Bristol Co., Waterbury, Conn..... 700

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Fred. Bredel Co., Milwaukee, Wis..... 710
Isbell-Porter Co., Newark, N. J..... 714
Johnson-Reynolds Co., Anderson, Ind..... 698
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(*Continued on page* 696.)

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As Superintendent of a Medium-Sized Gas Works.

Present position, manager and superintendent. Thoroughly understands both coal and water gas manufacture. Eight years' experience, divided between construction, operation and manufacture. Best of references from present employers and others. Address, "SUPERINTENDENT," 1558-5 Care this Journal.

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WANTED,

An Experienced Tar Distiller.

Address, with references and stating experience and salary expected,

"A. H. B.,"

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WANTED,

Salesman having Experience in the Pitch and Roofing Trade.

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Two Second-Hand Purifier Boxes,

In good condition, with chain lift and center-seal, capable of handling 40,000 cubic feet of gas daily. Address, "PURIFIERS,"

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(*Concluded from page* 695.)

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Continental Iron Works, Brooklyn, N.Y. 714
Davis & Farnum Mfg. Co., Waltham, Mass..... 712
Fred. Bredel Co., Milwaukee, Wis..... 710
Isbell-Porter Co., Newark, N. J..... 714
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 712
Logan Iron Works, Brooklyn, N.Y..... 716
R. D. Wood & Co., Philadelphia, Pa..... 714
Stacey Mfg. Co., Cincinnati, O..... 715
The Gas Machinery Co., Cleveland, O..... 700
The Western Gas Construction Co., Fort Wayne, Ind.. 720

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Fred. Bredel Co., Milwaukee, Wis..... 710
Isbell-Porter Co., Newark, N. J..... 714
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 712
R. D. Wood & Co., Philadelphia, Pa..... 714
Stacey Mfg. Co., Cincinnati, O..... 715
The Western Gas Construction Co., Fort Wayne, Ind... 720

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Isbell-Porter Co., Newark, N. J..... 714
Kerr Murray Mfg. Co., Fort Wayne, Ind 712
Ludlow Valve Manufacturing Co., Troy, N.Y..... 701
R. D. Wood & Co., Philadelphia, Pa..... 714
Stacey Mfg. Co., Cincinnati, O..... 715
The P. H. & F. M. Roots Co., Connersville, Ind..... 708
The Western Gas Construction Co., Fort Wayne, Ind.... 720

PUMPS.

De Laval Steam Turbine Co., Trenton, N. J..... 696

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Isbell-Porter Company, Newark, N. J..... 714
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Kerr Murray Mfg. Co., Fort Wayne, Ind..... 712
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R. D. Wood & Co., Philadelphia, Pa..... 714
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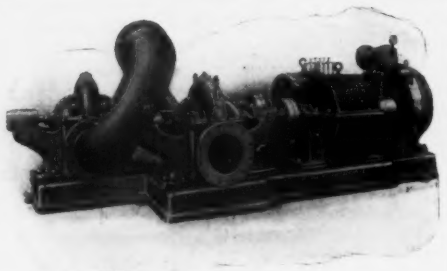

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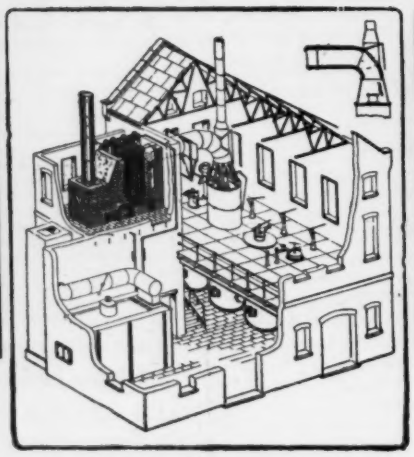

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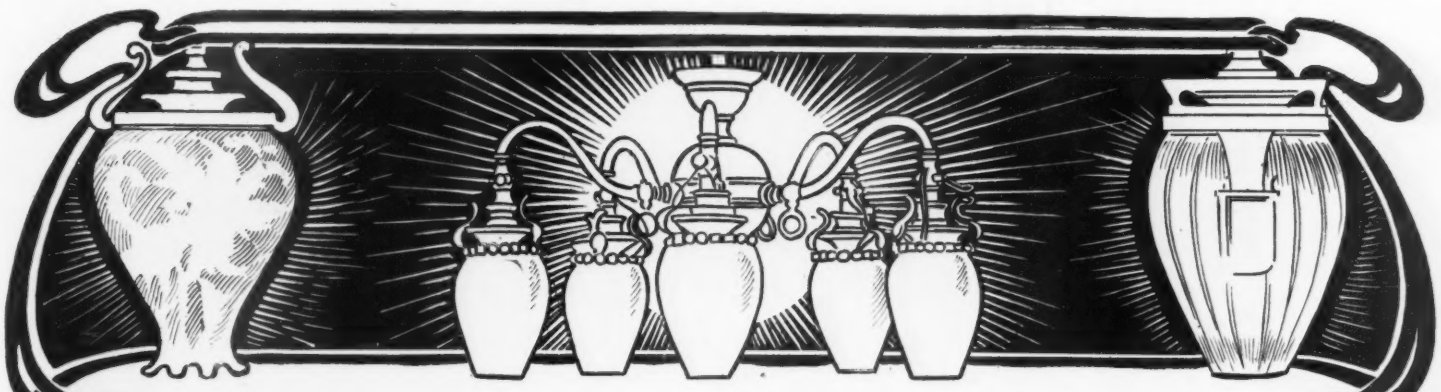

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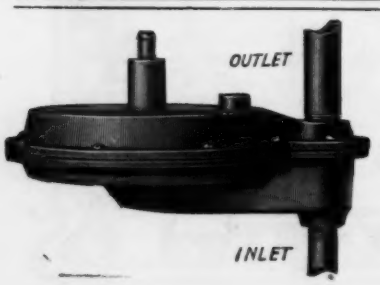

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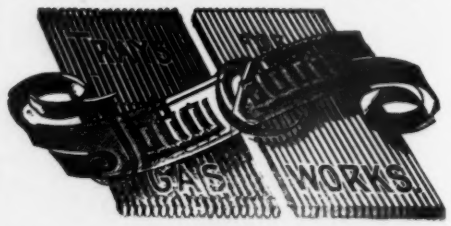

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TROY, N. Y., U. S. A.

Double and Single Gate Valves, ¼" to 72",

—FOR—

Gas, Water, Steam, Oil, Ammonia, Etc.

HOT GAS VALVES A SPECIALTY.

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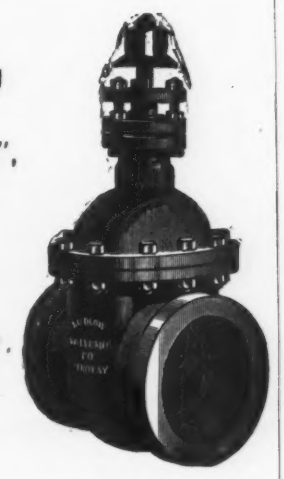

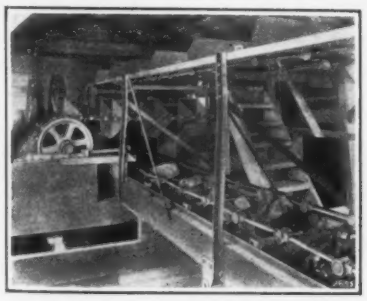

Gravity Discharge Bucket Conveyor

Delivering to the Monobar Conveyor in the 400-ton Locomotive Coaling Station erected for the Ulster & Delaware R. R. Co., Rondout, N. Y.

No One Conveyor will answer all demands in engineering work.

Our practice is to use the standard designs that best conform to the demands of the work to be done.

"It is the net result that interests us, and well-built old designs combined with novel application, clever gap stops and intense interest, will give highest results."

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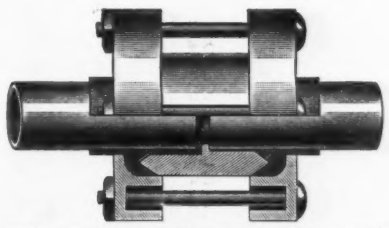
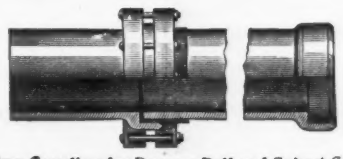
BRADFORD, PENNSYLVANIA, U. S. A.,

Patentee and Manufacturer of Specialties for Oil and Gas Lines.

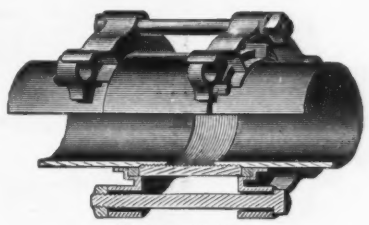


Insulating Coupling for Wrought Iron Pipe. Style 3.

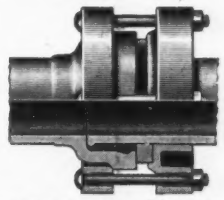


Insulating Coupling for Dresser Bell and Spigot Cast Iron Pipe. Style 6.

Regular Sleeve. Style 2.



Clamp. Style 4.



Clamps for Cast Iron Pipe. Style 4½.

Pipe Couplings, Sleeves, Clamps, Crosses, Tees and Ells.

My Insulating Coupling prevents the destruction of pipe by electrolytic action, in either water or gas lines.

SEND FOR CATALOGUE.

EMPIRE GAS IMPROVEMENT AND CONSTRUCTION CO.

This Company has purchased the patents and goodwill in the business hitherto carried on and owned by *A. M. Sutherland.* It is now ready to contract for the erection and installation of

ENTIRE GAS WORKS,

or any separate portion of the same, such as **Gasholders, Coal Gas Benches, Lowe-Sutherland** double-superheater **Water Gas Sets,** Scrubbers, Condensers, Exhausters, Purifying Boxes, Street Governors, Street Mains and Main Laying.

The high character of the work done by A. M. Sutherland during the past 15 years will be strictly adhered to and all work is warranted.

Mr. Sutherland remains with the Company for two years President and Director, and will give personal attention to contracts.

EMPIRE GAS IMPROVEMENT AND CONSTRUCTION CO., 49 Wall St., New York.

Lloyd's Rubber Lute

Or Positive Joint.

Patented November 8th, 1904, No. 774,439.

ONLY LICENSED BUILDERS:

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Isbell-Porter Co., Newark, N. J.
Stacey Manufacturing Co., Cincinnati, O.
Lloyd Construction Company, Detroit, Mich.

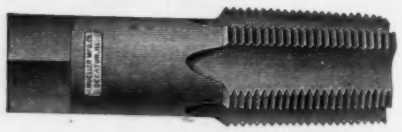
Infringing makers and those who buy from them are both equally liable in damages and both will be vigorously prosecuted.....

ERNEST F. LLOYD, Patentee,

DETROIT, MICH., March 27, 1905.

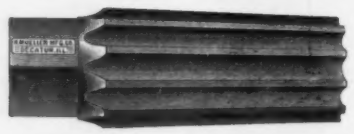
MUELLER HAND PIPE TOOLS.

HAND PIPE TAP.



C—1018.

HAND PIPE REAMER.



C—1019.

A tool made of high grade steel and tempered with a heat that is guessed at, may be a high grade tool and it may not.

Mueller Hand Pipe Reamers and Taps are made of high grade steel and tempered with a certain heat that is ascertained by the use of a special heat measuring instrument. They are uniformly high grade.

Mueller Hand Reamers and Taps have the cutting edges properly relieved so that they can operate cleanly and easily, and the machine work and gauging is to accurate standard. They are made in all sizes from ⅛ to 3-inch

Each tool is carefully inspected, is given a working test, bears the Mueller trade mark, and is *unconditionally guaranteed.*

We also make tapping machines, gas cocks and meter connections for gas works' use Catalogues upon application.

EASTERN DIVISION—Located at 254–258 Canal Street (cor. Elm), New York City, carries a full stock of Mueller goods.

THREE GRAND PRIZES were awarded Mueller Water, Gas and Plumbing goods, respectively, at St. Louis.

H. MUELLER MFG. CO.,

DECATUR, ILL., U. S. A. **NEW YORK, N. Y., U. S. A.**

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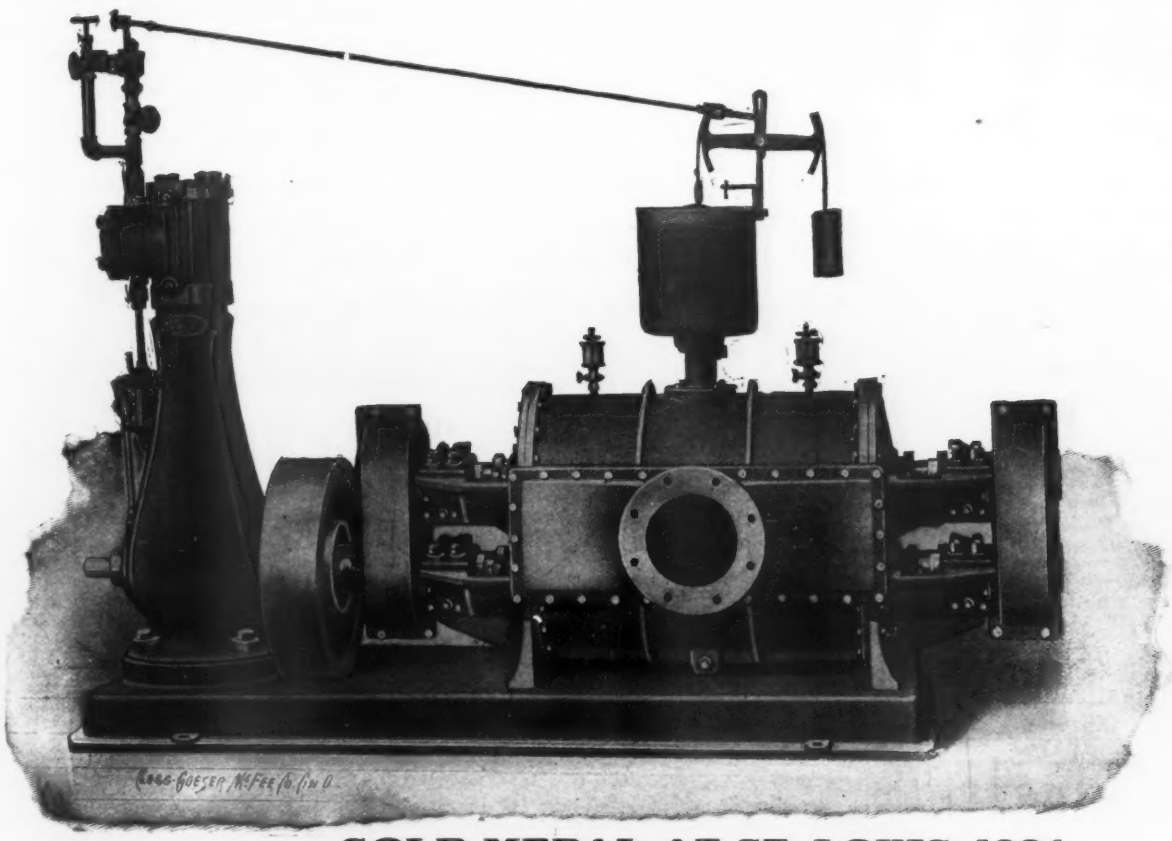

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Sizes for any required capacity.

Self-oiling, adjustable bronze bearings.

Most perfect and sensitive Governor.

Write for Catalogue.

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ARTHUR E. BOARDMAN, C.E.,

For several years associated with the late

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WILL CONTINUE THE BUSINESS OF

CONSULTING ENGINEER

For Gas, Water and Electric Light Companies, at

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TELEPHONE, 5534 BROAD.

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SPECIAL ATTENTION GIVEN TO THE REMODELLING AND EXTENDING OF THE PROPERTIES OF WORKS NOT UP-TO-DATE

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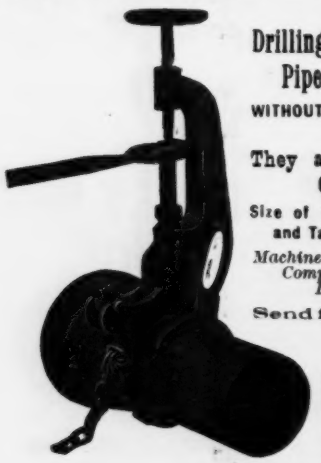
EMAUS PIPE FOUNDRY.
DONALDSON IRON COMPANY. EMAUS, PA.

MANUFACTURERS OF
CAST IRON PIPE AND SPECIAL CASTINGS
FOR WATER AND GAS.
Also, FLANGE PIPE, LAMP POSTS, Etc.

GAS TAPPING MACHINES
—FOR—
Drilling and Tapping Pipe under Pressure
WITHOUT ANY ESCAPE OF GAS.
They are Strong and Compact.
Size of Combination Drills and Taps ¾ to 4-inch.
Machines Sent to any Gas Company for Thirty Days' Trial.
Send for Circulars.



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DAYTON, O.

"THE MINER"
Globe Street and Boulevard Lamps.
Cheapest and Best
THOUSANDS IN USE WITH INCANDESCENT BURNERS.
Send for Catalogues.
THOMAS T. W. MINER,
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COAL AND COKE HANDLING MACHINERY.
Our specialty is building machinery for the economical handling of coal and coke in gas plants. Send for new catalogue containing illustrations and descriptions of plants we have installed, if you are interested in the economical handling of these materials.
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Formerly with the Continental Iron Works.
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Drawings, Specifications and Estimates furnished for the construction of new works or alteration of old works. Special attention given to Patent Office drawings.
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GASHOLDER TANKS AND GAS WORKS MASONRY COMPLETE.
Plans prepared and Estimates furnished at short notice.
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WARREN FOUNDRY AND MACHINE CO.
Established 1856. Works at Phillipsburgh, N. J.
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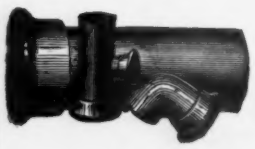


CAST IRON WATER AND GAS PIPE,
FROM THREE TO FORTY-EIGHT INCHES DIAMETER. ALSO, ALL SIZES OF
Flange Pipe for Sugar House and Mine Work. Branches, Bends, Retorts, etc., etc.

CHARLES MILLAR & SON CO., Selling Agents, Utica, N.Y.
Flanged Pipe and Fittings, Hydrants, Gates, Pig Lead, Jute, etc.
UTICA PIPE FOUNDRY CO.
Manufacturers of Lead Pipe, Solder, etc., and Jobbers of Plumbers' and Tinners' Goods.
CAST IRON PIPE and SPECIALS FOR WATER AND GAS.
Wholesale Eastern Agents AKRON VITRIFIED SEWER PIPE.

SAFETY GAS MAIN STOPPER COMPANY,
For Shutting Off Gas in Mains
Any size gas main can be shut off in 30 seconds. : : :

Temporarily during alterations and repairs. : : : :
STOPPERS SENT ON TRIAL.
Address: SAFETY GAS MAIN STOPPER CO., 1668 Park Ave., New York City.

This is No. 2.
Height, 36 inches.
Diameter, 12 "
Shipping weight, 80 lbs.
Net weight, 50 lbs.
The products of combustion are entirely separate from the water. Entire water surfaces are tinned.
Price, $35.00.

HOT WATER
FOR BATHROOM AND KITCHEN
is most easily, quickly and economically supplied by a
Humphrey Crescent Instantaneous Water Heater.
Prices range from $20 to $45.
Every Heater GUARANTEED.
Set a heater for every gas consumer. You will please them and increase sale of gas at the same time.
Send to-day for catalogue and discounts to
HUMPHREY CO.,
Kalamazoo, Mich.,
The only manufacturers in the World of a COMPLETE LINE OF INSTANTANEOUS WATER HEATERS.

GAS ANALYST'S MANUAL,
By JAQUES ABADY, M. Inst. Mech. E.
(Incorporating F. W. Hartley's "Gas Analyst's Manual" and "Gas Measurement.")
Ninety-three Illustrations and Nine Folding Plates. Bound in Handsome Half Leather. Price, $6.50.
For Sale by **A. M. CALLENDER & Co., 42 Pine St., New York City.**

AMERICAN METER CO.,

NEW YORK, ST. LOUIS, PHILADELPHIA, SAN FRANCISCO, CHICAGO,

Photometrical and Experimental Apparatus.

PUBLIC LIGHTING TABLE.

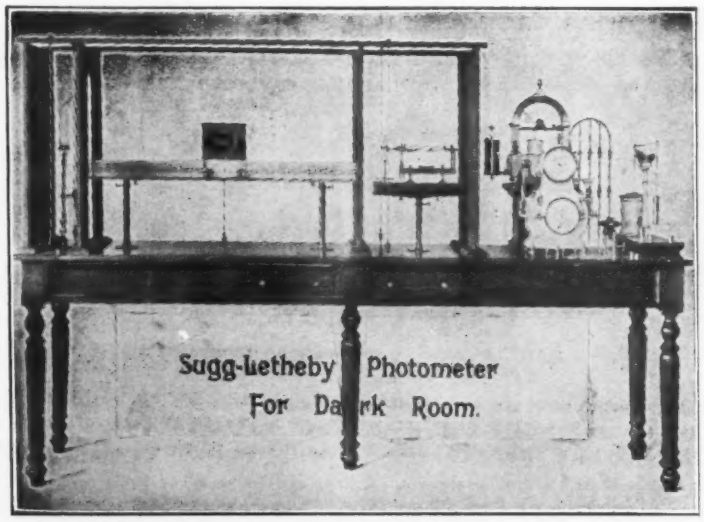
MAY, 1905.

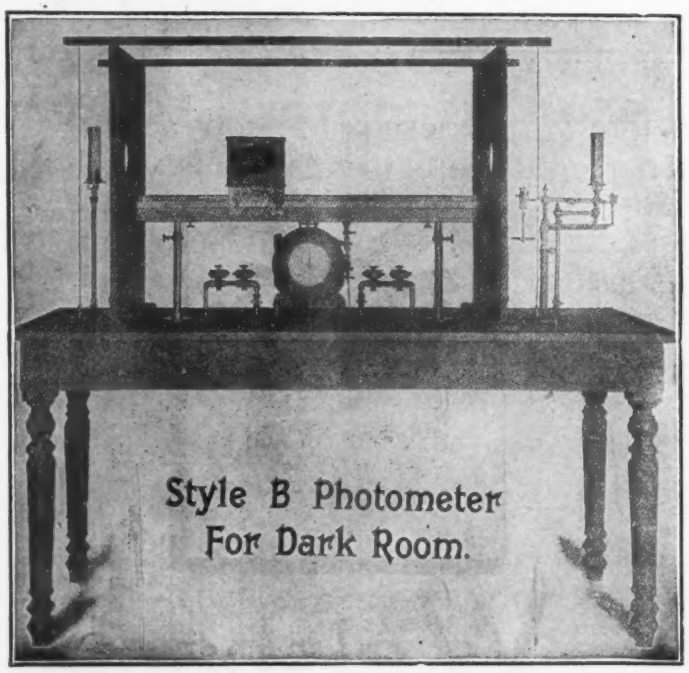
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.
Mon.	1	7.30 PM	4.00 AM
Tue.	2	7.30	4.00
Wed.	3	7.30	4.00
Thu.	4	7.30 NM	4.00
Fri.	5	7.30	4.00
Sat.	6	7.30	4.00
Sun.	7	7.30	3.50
Mon.	8	7.30	3.50
Tue.	9	10.30	3.50
Wed.	10	11.20	3.50
Thu.	11	12.00 FQ	3.50
Fri.	12	12.40 AM	3.50
Sat.	13	1.10	3.50
Sun	14	1.50	3.40
Mon.	15	2.30	3.40
Tue.	16	3.10	3.40
Wed.	17	No L.	No L.
Thu.	18	No L. FM	No L.
Fri.	19	No L.	No L.
Sat.	20	7.40 PM	10.10 PM
Sun.	21	7.50	11.10
Mon.	22	7.50	12.00
Tue.	23	7.50	12.40 AM
Wed.	24	7.50	1.20
Thu.	25	7.50 LQ	1.50
Fri.	26	7.50	2.20
Sat.	27	7.50	2.50
Sun.	28	7.50	3.20
Mon.	29	7.50	3.30
Tue.	30	7.50	3.30
Wed.	31	7.50	3.30

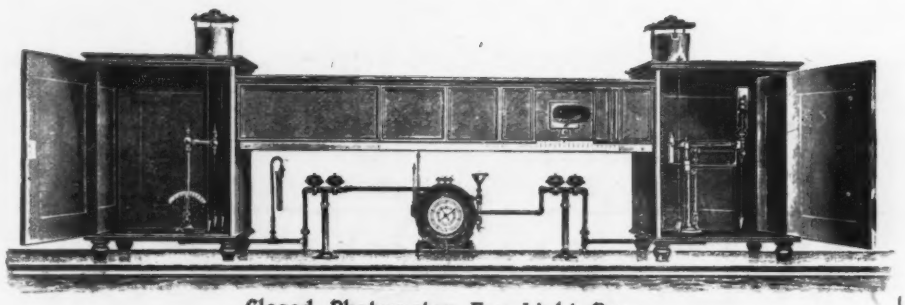
TOTAL HOURS DURING 1905.

By Table No. 1.

	Hrs.Min.
January	240.50
February	192.20
March	207.00
April	175.10
May	161.00
June	139.50
July	149.00
August	161.50
September	173.00
October	205.00
November	211.00
December	229.00
Total, yr.	2245.00







Closed Photometer For Light Room.

CIRCULARS SENT ON REQUEST.

PUBLIC LIGHTING TABLE.

MAY, 1905.

Day of Week.	Date.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
		P.M.	A.M.
Mon.	1	6.45	4.00
Tue.	2	6.45	4.00
Wed.	3	6.45	4.00
Thu.	4	6.45	4.00
Fri.	5	6.45	4.00
Sat.	6	6.45	4.00
Sun.	7	6.55	3.40
Mon.	8	6.55	3.40
Tue.	9	6.55	3.40
Wed.	10	6.55	3.40
Thu.	11	6.55	3.40
Fri.	12	6.55	3.40
Sat.	13	6.55	3.40
Sun.	14	7.00	3.30
Mon.	15	7.00	3.30
Tue.	16	7.00	3.30
Wed.	17	7.00	3.30
Thu.	18	7.00	3.30
Fri.	19	7.00	3.30
Sat.	20	7.00	3.30
Sun.	21	7.10	3.15
Mon.	22	7.10	3.15
Tue.	23	7.10	3.15
Wed.	24	7.10	3.15
Thu.	25	7.10	3.15
Fri.	26	7.10	3.15
Sat.	27	7.10	3.15
Sun.	28	7.15	3.15
Mon.	29	7.15	3.15
Tue.	30	7.15	3.15
Wed.	31	7.15	3.15

TOTAL HOURS DURING 1905.

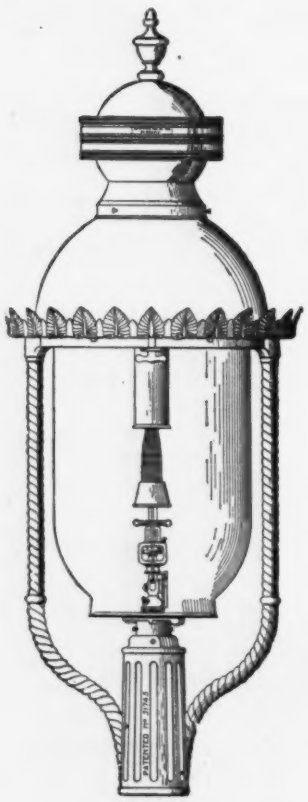
By Table No. 2.

	Hrs.Min.
January	423.20
February	355.25
March	355.35
April	298.50
May	264.50
June	234.25
July	243.45
August	280.25
September	321.15
October	374.30
November	401.40
December	433.45
Total, yr.	3987.45

NEW YORK, 9 Libert Street. PHILADELPHIA, Broad and Arch Streets. CHICAGO, Foot of Orleans Street.
BOSTON. 814 Beacon Building. ST. LOUIS, 712 Roe Building. SAN FRANCISCO, 712 Polk Street.

WELSBACH STREET LIGHTING COMPANY

.... OF AMERICA ....



No. 36.

Controls and Operates the

Welsbach System of Street Lighting,

Which includes its specially DESIGNED AND PATENTED BURNER for STREET and PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in 150 Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

Correspondence Solicited from Gas Companies and Others interested in Municipal and Outside Lighting.

No. 38.

AN underlying principle in business is to show an increase each year---to grow. The astute dealer not only seeks to retain this year's customers, but to attract new trade next year.

The formula is simple---

THIS SHIELD IS THE WELSBACH TRADE MARK.

IT IS A GUARANTEE AND A PROTECTION.

Sell The Welsbach Brands.

The imitation stuff is bad for the customer---which is bad for you.

The genuine Welsbachs---Burners or Mantles---make satisfied customers---keep customers---MAKE NEW ONES.

And your profit isn't merely dollars and cents.

WELSBACH CO.,

Broad and Arch Sts., PHILADELPHIA.

THE UNITED GAS IMPROVEMENT COMPANY

For the Year Ending December 31st, 1904, has been Awarded Contracts for 45 Sets of

Standard Double-Superheater Lowe Water Gas Apparatus.

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Reading, Pa.	**Watertown, N. Y.**	**Battle Creek, Mich.**
Augusta, Me.	**Tampa, Fla.** (3d contract).	**Mechanicsburg, Pa.**
Bangor, Pa.	**Westchester, N. Y.** (3d contract).	**Excelsior Springs, Mo.**
Woonsocket, R. I. (2d contract).	**Bridgeport, Conn.** (2d contract.)	**Bristol, Conn.**
Brooklyn, N. Y. (4th contract).	**St. Paul, Minn.** (2d contract).	**Jersey Shore, Pa.**
Cincinnati, O. (2d contract).	**Springfield, Mass.** (2d contract).	**Vicksburg, Miss.**
Scranton, Pa. (3d contract).		

TOTAL SETS, 1904, ... 45
TOTAL DAILY CAPACITY, 1904, ... 56,325,000 cubic feet.
TOTAL SETS TO DATE, ... 553
TOTAL DAILY CAPACITY, ... 419,180,000 cubic feet.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia

Established 1858. Incorporated 1890.
CHAS. E. GREGORY, Prest. DAVID R. DALY, V.-Prest. & Treas.
H. D. ABERNETHY, Sec.

J. H. Gautier & Co.

Greene & Essex Streets,
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CLAY GAS RETORTS, FIRE CLAY TILES,
FIRE BRICK and FIRE CLAY SPECIALTIES.

Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

SOLE MANUFACTURERS OF THE

FLEMMING GENERATOR GAS FURNACE

Brooklyn Fire Brick Works,

OFFICE AND WORKS:
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MANUFACTURERS OF

CLAY GAS RETORTS & SETTINGS, GENERATOR LININGS. SPECIALTIES.

NATIONAL PYROGRANIT COMPANY,

MANUFACTURERS OF

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Special Shapes, etc.

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WORKS:
South River, N. J.

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Consulting Engineer

AND

CONTRACTOR,

PARK ROW BUILDING, N. Y.

Established 1846.

Adam Weber Sons.

Manhattan Fire Brick and Enameled Clay Retort Works.

Works at Weber, on the Raritan River, Middlesex County, N. J.

GENERAL OFFICES: Park Row Bldg., N. Y. City.

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Modern Coal Gas Plants,

With either Horizontal or Inclined Retorts, Half-Depth and Full-Depth Recuperative Furnaces, Adam Weber Patents.

MODERN BENCH IRONWORK.

Linings for Water Gas Apparatus, High Grade Fire Brick of All Descriptions, Ground Fire Clay, Ground Fire Brick in Bulk or Barrels.

ISAAC C. BAXTER, President.
Works.
LOCKPORT STATION, PA.

ESTABLISHED 1864.

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HENRY MAURER & SON,

(ESTABLISHED 1856.)

EXCELSIOR FIRE BRICK & CLAY

RETORT WORKS

WORKS, Perth Amboy, N. J.
OFFICE, 418 to 422 East 23d St., N. Y.

Clay Gas Retorts,

BENCH SETTINGS,

Fire Brick, Tiles, Etc.

GEROULD'S IMPROVED RETORT CEMENT

A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

Price List, f.o.b. BLOOMINGTON, INDIANA.
In Casks, 400 to 800 pounds, at 5 cents per pound.
In Kegs, 100 to 200 " " 6 " "
In Kegs less than 100 " " 7 " "

C. L. GEROULD, BLOOMINGTON, IND.

For orders East of Buffalo, N. Y., or Pittsburg, Pa., freight will be paid to these points.

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Consulting Engineers.

Builders of UP-TO-DATE Machinery and Appliances for Coal and Water Gas Plants. :: :: :: :: ::

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AND ESTIMATES
PREPARED.

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THEO. J. SMITH, Prest. J. A. TAYLOR, Sec
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BALTIMORE RETORT & FIRE BRICK CO.

MANUFACTORY AT
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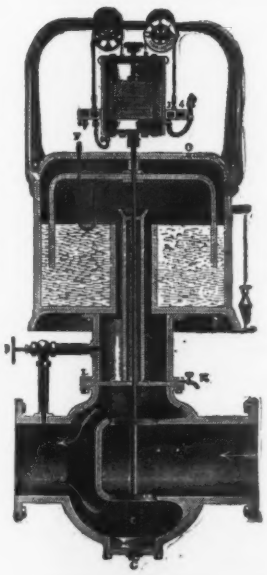

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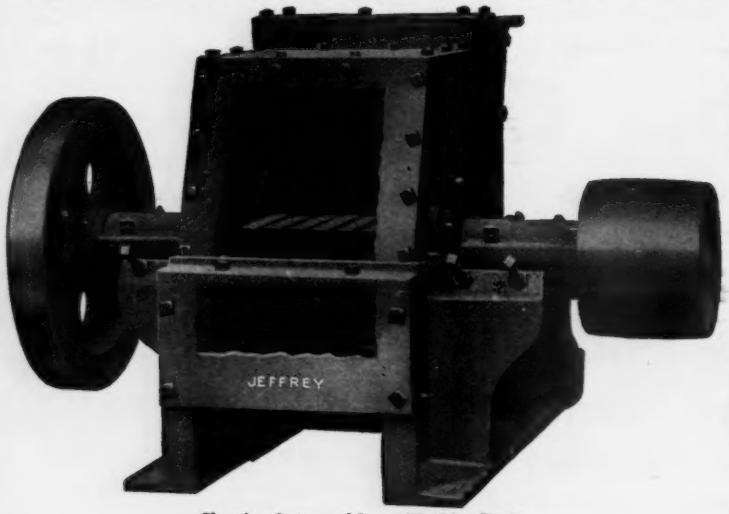

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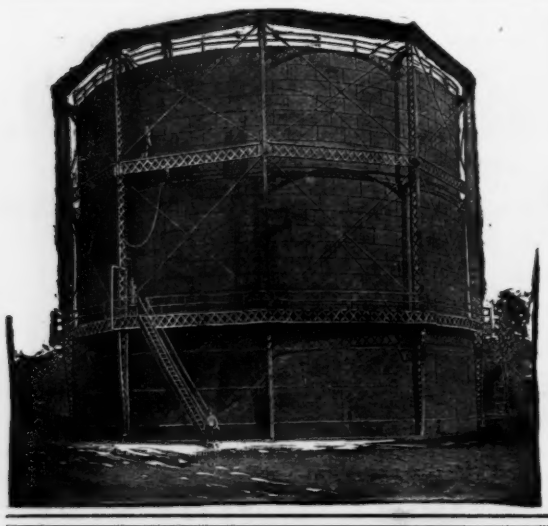

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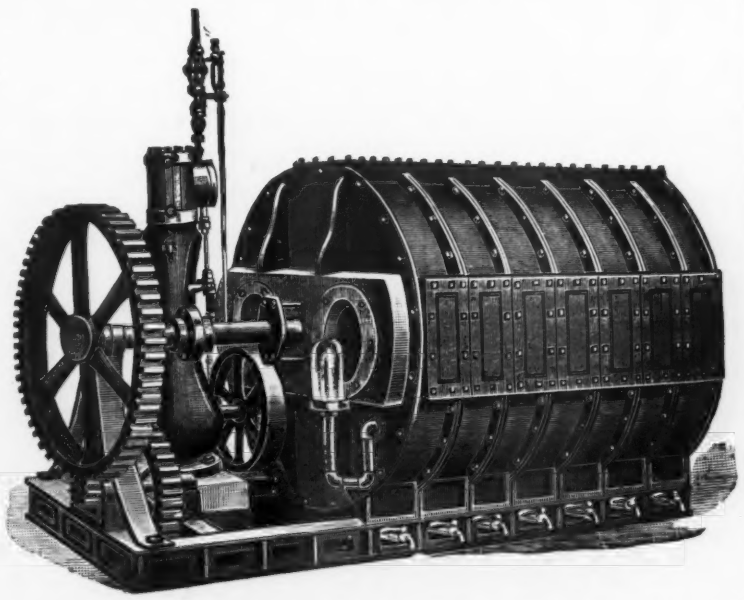

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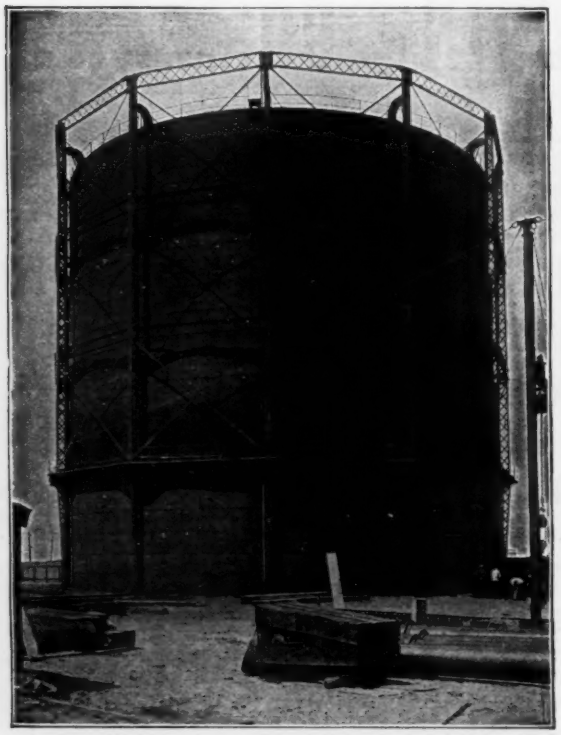

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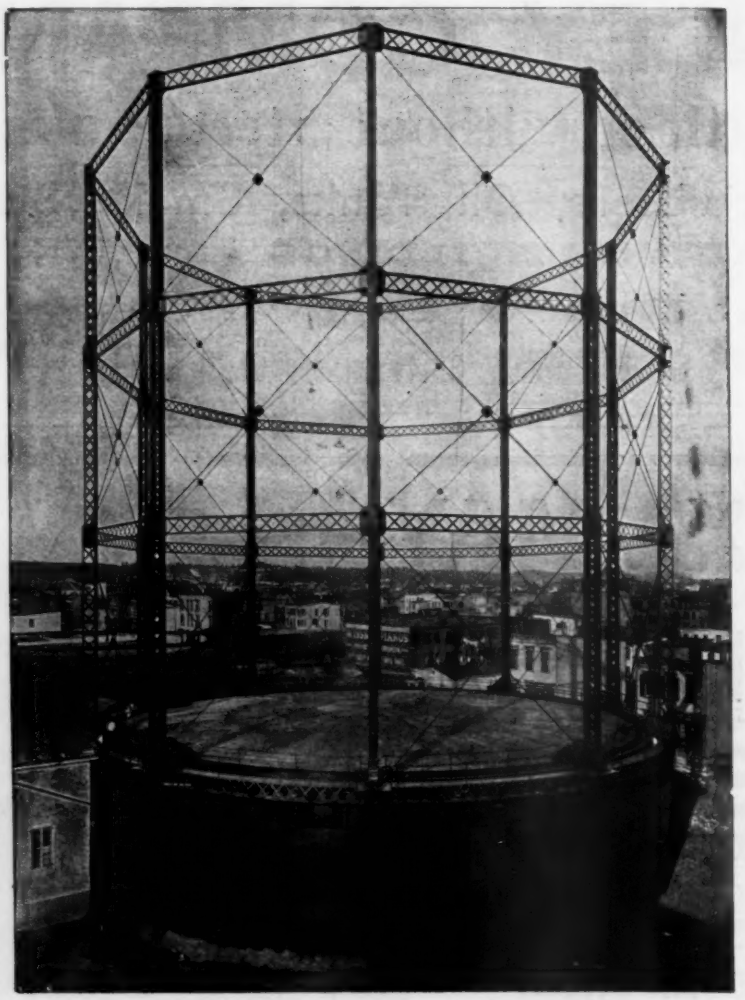

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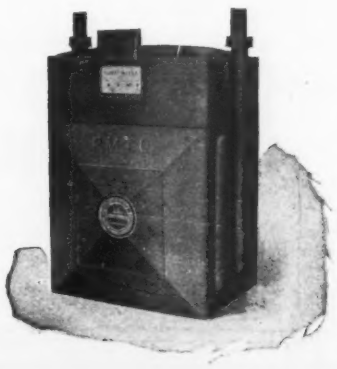

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